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THE

EXAMINER IN ANATOMY

THE

EXAMINER IN ANATOMY

A COURSE OF
INSTRUCTION IN THE METHOD OF ANSWERING
ANATOMICAL QUESTIONS

BY

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PREFACE.

THROUGHOUT the time I held the chair of Anatomy at St. Mary's Hospital, it was my custom to require each student to give written answers to a number of questions before presenting himself for the public examinations. From such experience I found that even those who possessed a good knowledge of the subject failed in the first instance to express themselves satisfactorily, many not realising with sufficient exactness the precise question, and so being too diffuse in their answers, others, with less intelligence, striving to make up for a deficient knowledge by extending their answers to collateral parts not included in the questions. Almost without exception the answers to the earlier papers indicated an absence of method, often merely a want of experience in transcribing the thoughts on paper. To obviate this I advised the following plan: 1st. That each question should be read several times until its direct bent should be ascertained; 2nd, that a number of heads should be written upon a slip of paper, and, after deliberation, arranged numerically according to their respective importance. 3rd, That the answer should be developed by a full description under the different heads.

The plan worked admirably. Some twenty questions formed sufficient practice for the more intelligent students, others preferring more, whilst all found the experience to develop their power of expressing themselves at the same time that it impressed the subject-matter more distinctly upon their memory.

With such experience on the advantage of test questions, I was not unwilling, at the request of Messrs. Smith, Elder & Co., to collect and arrange a series of anatomical questions, and to append formulated replies to them, believing that such a work would diminish to some extent the difficulties in the way of acquiring a thorough knowledge of anatomy.

By the kind assistance of Mr. George Giles, M.R.C.S., my late Assistant Demonstrator—who has relieved me of a great deal of that labour which is entailed in writing upon subjects our knowledge of which, though large, is limited—the work has been accomplished in a manner which, I trust, will be found to supply students of anatomy with that form of assistance which I have learned by experience they require.

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QUESTIONS AND ANSWERS
ON
ANATOMY.

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CHAPTER I.

OSTEOLOGY.

In answering questions on the bones, it is advisable to proceed systematically; first specifying the various parts of the bone for examination, and then proceeding to give a detailed, but terse description of each, completing the description of every point before proceeding to the next.

The following scheme will be found useful:—

1. General shape and size.
2. Position in the skeleton.
3. Relations with neighbouring bone.
4. Systematic description.
5. Structure.
6. Mode of development; number and position of ossific centres; the time of their appearance; and union of epiphyses.

- Long bone
  - Upper extremity
  - Lower extremity
    - Articular surfaces
      - Form
      - Direction
      - Extent
    - Other points
      - Description of these
  - Shaft
    - Borders
      - Extent
      - Character (rough, distinct, &c.)
      - Direction
    - Surfaces
      - Between what borders
      - Direction (taken at right angles to the surface)
      - Character
      - Markings (muscular impressions, foramina, &c.
- Flat bone
  - Surfaces
    - Direction
    - Outline (quadrangular, triangular, &c.
    - Form (convex, concave, &c.)
    - Character
    - Markings
  - Borders
    - Extent
    - Lips
    - Muscular attachments, &c.
  - Angles
    - How formed
    - Character
  - Processes
    - Shape
    - Size
    - Character
    - Markings
- Mixed
  - Borders
  - Extremities
  - Surfaces
  - Processes
    - As above
- Short
  - Surfaces
    - Articular
    - Non-articular
  - Processes
    - As above

1. Describe the occipital bone, (1) its relations and mode of connexion with other bones, (2) the foramina existing in it, or into whose formation it enters, naming, but not further describing, the parts passing through them, (3) the muscles attached to it, and their points of attachment; then give its mode of development and ossification.

In the first portion of this question is required a mention of the sutures between the occipital and the parietal and temporal, as also its fusion with the sphenoid, and its articulation with the atlas, together with an enumeration of the ligaments of that joint, and of those connecting the occipital with the axis; in the second, a table of the foramina in the bone with the structures which they transmit; in the third, the points of attachment of the muscles; and in the last, the number and time of appearance of the ossific centres, from which the development of the bone proceeds.

2. Describe the shape and position of the occipital bone, its connexions with other bones, and the blood vessels and nerves in its immediate vicinity.

In this question the general shape merely is required, and not a minute description of the bone—its hollowed lozenge form, its basilar, and jugular processes.

As to position, it is the principal bone of the base of the skull, by which the latter is balanced on the vertebral column. It is connected by anchylosis with the sphenoid; by synarthrosis with the temporal and parietal bones; by arthrosis with the atlas.

The vessels and nerves requiring mention would be;—in relation with the internal surface of the bone, the lateral sinuses ending in the internal jugular vein, and the longitudinal and occipital sinuses; the parts of the eighth nerve passing out at the posterior lacerated foramen, the ninth nerve issuing at the anterior condyloid foramen; the vertebral arteries entering the skull at the foramen magnum, and joining to form the basilar, which grooves the basilar process; and the posterior meningeal artery. In relation with the outer surface, the occipital vessels, and greater and lesser occipital nerves, and some branches from the posterior auricular artery and nerve would be the principal points for notice.

3. With what bones does the occipital bone articulate?

4. What parts pass through the foramen magnum?

Spinal cord and membranes, viz.: dura mater, arachnoid, and pia mater; vertebral vessels, their spinal branches, and the spinal accessory nerves.

5. Describe the parietal bone, its articulation, and development.

6. Describe the sphenoid bone, state its position in the skull, and the bones with which it articulates.

These two questions involve complete and systematic descriptions of the bones.

7. Enumerate the cavities and fossæ that the sphenoid bone contributes to form; mentioning the portion of the bone by which they are respectively bounded.

The cavities and fossæ bounded by the sphenoid are the fossæ of the skull, by the upper surfaces of the body and cranial aspect of the greater and lesser wings; the orbits, by the anterior surface of the greater wings; the nasal fossæ by the anterior and under part of the body, and inner aspect of the pterygoid processes; the temporal fossæ, by the outer surface of the greater wings above the pterygoid ridges; the zygomatic fossæ, by the portion of the great wing below the pterygoid ridges, and the external surface of the external pterygoid plate; and the spheno-maxillary fossæ, by the lower part of the anterior surface of the greater wings, and by pterygoid processes.

8. Mention the objects seen on the upper surface of the petrous portion of the temporal bone.

The points requiring mention here are, the depression near the apex, for the Gasserian ganglion, the hiatus Fallopii, with the groove leading to it, the eminence marking the position of the superior semicircular canal, and external to this the thin translucent plate of bone forming the roof of the cavity of the tympanum.

9. Describe the temporal bone at birth, and contrast it with the bone in the adult.

At birth, the temporal bone consists of four separate parts: a squamous portion, including the zygoma, a petro-mastoid portion, united to the former piece by a suture; the tympanic bone, a slender ring of bone incomplete above; and the styloid process.

In the adult, these parts are united into one bone. The mastoid process of the child is quite rudimentary, and the petrous portion shows much more clearly than in the adult the outlines of the internal ear.

Lastly, whereas, at birth, the membrana tympani is attached to the tympanic bone, and is, therefore, on a level with the external aspect of the bone, in the adult an external auditory meatus, three quarters of an inch in length, has been developed.

10. Give a complete description of the horizontal portion of the frontal bone.

11. Describe the ethmoid, and its connections with other bones; and mention the number and position of the ossific centres from which it is developed.

A complete description of the bone is required.

12. Describe briefly the appearances presented by a transverse section of the ethmoid bone, supposing it to have been cut through about the middle.

In the middle line would be seen a vertical partition, probably bent a little to one side. This would be seen to spring above from a horizontal plate of bone, from each side of which would descend a scroll of bone, limited externally by a straight plate, on the inner side of which would be exposed some of the ethmoidal cells. Projecting from the inner wall of the cells would be observed two processes of bone bending downwards—the one, the superior turbinated, close to the horizontal plate; the other, the middle turbinated, about midway between the upper and lower borders of the lateral mass.

13. Enumerate the foramina in the superior maxillary bone.

A list of the foramina in the bone is required, but the structures which pass through them are not to be mentioned, nor is any further information expected.

14. Give a complete description of the right palate bone.

The growth of the bone is not required.

15. Distinguish the several 'palatine' canals and the parts which pass through them.

In the suture between the vertical portion of the palate bone and the superior maxillary bone is the posterior palatine canal, which transmits the large descending palatine vessels and nerve, and near it two smaller canals which transmit the small and external palatine nerves. In the suture between the palatine processes of the superior maxillary bone is the anterior palatine canal, which is subdivided into four portions, of which the lateral transmit the nasopalatine arteries, and the median the nasopalatine nerves, the nerve of the left side usually occupying the anterior subdivision.

16. How would you distinguish to which side a lachrymal bone belonged?

By placing it in position, the external surface being known by the ridge and groove, the groove being next the anterior border; the lower border by the small hook-like process that projects from it.

17. Contrast the lower jaw in the child and in the adult.

In the child, the bone consists of two pieces (before the second year). The angle is very obtuse. The ramus is much shorter in proportion to the horizontal ramus than in the adult. The alveolar processes are but little developed.

In the adult the two pieces have been anchylosed together at the symphysis. The angle of the jaw is almost a right angle. The alveolar processes are completely developed.

18. What bones would be cut through in making a median vertical section of the skull? Enumerate the various eminences and depressions that would be seen along the inner edge of such a section. What cavities would be laid open by it?

The bones cut through in such a section would be the vertical portion of the frontal, the parietals at the interparietal suture, the occipital, the sphenoid, the ethmoid; while the nasals, superior maxillaries, and palate bones of opposite sides would be separated along the line of their sutures, and the vomer split into its component halves above, and, as it bulges generally to the one side, cut through below. Along the inner edge of this section would be seen, on the vault of the skull, one or more depressions for the lodgment of the glandulæ Pacchionii; midway down the vertical portion of the occipital an eminence, the internal occipital protuberance; a little lower would be a gap, marking the position of the foramen magnum; next a plate of bone, the basilar process, prolonged upwards into a projection, the dorsum Ephippii; immediately in front of this a depression, the sella turcica; next an eminence, the olivary process; in front of this the groove for the optic commissure would be cut across; after which would succeed the flat horizontal plate of the ethmoid, terminating in front in a projection, the crista galli, between which and the vertical portion of the frontal is a depression, the foramen cæcum.

The cavities laid open would be the brain case, the nasal fossæ, and the sphenoidal and frontal sinuses.

19. By what bones are the three lacerated foramina of the skull respectively formed? Name the structures which they transmit.

The anterior lacerated foramen is a space between the lesser and greater wings of the sphenoid, closed in by the articulation of those bones with the frontal. It transmits the third, fourth, superior division of the fifth, and sixth nerves, and the ophthalmic vein, and twigs of the sympathetic nerve.

The middle lacerated foramen is an irregular opening situate between the body and great wing of the sphenoid and the apex of the petrous portion of the temporal bone; it is closed in the recent state by a cartilaginous plate, along which pass, in a horizontal position, the internal carotid artery and vidian nerve, while a small meningeal twig of the ascending pharyngeal artery gains entrance to the skull, passing upwards through it.

The posterior lacerated foramen is of oval form, and is placed in the course of the suture between the petrous portion of the temporal and the occipital bone; it transmits the internal jugular vein, the glosso-pharyngeal, pneumogastric, and spinal accessory nerves, and the small posterior meningeal artery.

20. Enumerate the principal vascular markings found in the interior of the skull; mentioning their position and the vessels by which they are filled in the recent state.

The principal vascular markings on the interior of the skull are the groove for the superior longitudinal sinus along the middle line of the vault, terminating in a depression about the middle of the vertical portion of the occipital bone, for the torcular Herophili; from this diverge outwards, one on each side, the two grooves for the lateral sinuses, which, after grooving successively the occipital, parietal, mastoid portion of temporal, and occipital again, terminate in the jugular fossæ, from which commences the internal jugular vein; along the ridge leading downwards from the torcular Herophili may be seen a very small groove for the occipital sinus.

Along the side of the body of the sphenoid is a groove for the lodgment of the internal carotid artery and the cavernous sinus. Proceeding from the foramen spinosum outwards and upwards to the anterior inferior angle of the parietal bone is the groove for the middle meningeal artery, which is seen to divide in an arborescent manner into several branches, reaching up to the vertex, and as far back even as the occipital bone. Along the superior border of the petrous bone is a small groove for the superior petrosal sinus, while a slight groove for the inferior petrosal sinus runs along the line of suture between the petrous portion and the basilar process.

The circular and the transverse sinuses often mark the bones, the one the sella turcica, and the other the basilar process of the occipital bone.

21. What are the thickest and what the thinnest portions of the brain case? On account of this disposition of strength what part of the skull would be fractured by a fall on to the vertex from a height?

The thickest portions of the skull are its vault, and the petrous portion of the temporal bone. The base of the skull is, on the average, much thinner; the thinnest portions of the brain-case are the orbital plates, and the horizontal plate of the ethmoid. On account of the great strength, and of the bell-shape of the vault of the skull, it is seldom fractured by a fall on the head. In such an accident the base of the skull is broken by the impact of the weight of the body on the occipital condyles, the vertebral column being sometimes driven through it into the cavity of the skull.

22. Describe a lumbar vertebra. What are the chief points by which it may be distinguished from a dorsal vertebra?

In the first portion of this question is required a description of a typical lumbar vertebra. In the second part, the points requiring mention are the size and shape of its body, wider from side to side than before back, the absence of any articular facet for the head of a rib, the direction of the superior articular processes—viz., backwards and inwards, the horizontal position of its spine, and the length and flatness of the transverse processes.

23. Describe the state of ossification of a vertebra at the time of birth; and the progress of change afterwards up to complete ossification.

In a vertebra at the time of birth would be found three ossific centres, one for the bodies and another on each side for the pedicles and laminæ. These two latter unite with each other during the first year, and with the body in the third. About the sixteenth year would appear three epiphysal centres, one for the spinous, and one for each transverse process, and about the twentieth year two ossific points, one each for the upper and lower plates of the body. The bone is completely ossified about the thirtieth year.

24. Give a complete description of the first cervical vertebra.

25. Describe the peculiarities of the first and last dorsal vertebræ.

The first dorsal vertebra is somewhat similar in general shape to a cervical vertebra; it has on each side a complete articular facet for the head of the first rib, as well as a half facet on its lower border for the head of the second rib.

The last dorsal vertebra approaches in form that of a lumbar vertebra; its inferior articular processes have the same direction as those of a lumbar, forwards and outwards; it has on each side an entire facet for articulation with the head of the twelfth rib, and its very small transverse process has no articular facet for the tubercle of a rib.

26. How are the articular facets for the heads of the ribs distributed amongst the dorsal vertebræ?

First vertebra one entire facet above, and a half facet below; 2nd, 3rd, 4th, 5th, 6th, 7th, and 8th, a half facet above and a half below; the 9th a half facet above only; and the 10th, 11th, and 12th each a whole facet.

27. Mention the bones connected with the sacrum, and describe the mechanism by which it is retained in position.

The sacrum articulates with the vertebral column above, with the cocyx below, and with the haunch bone on each side. It is retained in position, 1st, by its peculiar shape, and 2nd, by strong ligaments. 1st, looking at the entire bone, it forms a double wedge larger above than below, and before than behind—the latter providing against dislocation backwards. If, however, a horizontal section be made across the sacrum opposite the middle of the auricular surfaces, it will be seen that there, instead of being smaller, the posterior measurement exceeds the anterior by, perhaps, as much as half an inch, hence preventing displacement forwards. 2nd. By the

synchondrosis of the auricular surfaces, and by the very strong posterior sacro-iliac ligaments, the varied direction of the fibres of which alike tend to prevent both anterior and posterior dislocation.

28. What arrangements exist in the construction of the vertebral column for preventing the shock of a fall on to the buttocks being transmitted to the brain?

The arrangements in the spinal column by which the transmission of a shock is prevented from being instantaneously transmitted are as follows: 1st. The column is composed of a number of segments termed vertebræ. 2nd. These segments are separated by intervertebral discs, which are of a highly elastic nature. 3rd. The connections between the separate parts, except in the sacrum, admit of a certain amount of flexion both laterally and in an antero-posterior direction. 4th. The triple curve in the vertebral column materially diminishes any force acting on the column in the direction of its length. By these means the effect of a force, instead of being instantaneous, is distributed over a comparatively long space of time, and hence becomes proportionally small during any given instant of that space.

29. Give a description of the characters common to the ribs.

30. Describe the first rib, its form, position, and degree of mobility. In what respects does this rib differ from all the others; what muscles are attached to it; and what great vessels are in contact with its upper surface?

In this question is required in the first place, a description of the bone. It is the least moveable of the ribs, being anchylosed in front to the manubrium sterni; it is the shortest, broadest, and most curved of all the ribs; its angle coincides with its tubercle, so that it is often described as having none; its surfaces are directed upwards and downwards, and the articular facet on the head is not divided into two parts by a horizontal line. The muscles attached to it requiring mention are the anterior and middle scalenes, the first serration of the serratus magnus, the intercostal muscles of the first space, the accessorius ad sacro-lumbalem and cervicalis ascendens, and the first levator costæ; at its junction with its cartilage the subclavius takes origin.

The 'great vessels' are the subclavian artery and vein.

31. How do the last two ribs differ from the remainder of the costal series, and from each other?

The eleventh and twelfth ribs are much less curved than the others; they do not articulate with a transverse process and therefore, possess no tubercle; they are free in front, being merely tipped with cartilage, and so are termed floating ribs. Both are short, but the twelfth is much the shorter. The eleventh has a slight groove on its lower border, and a slight angle close to its anterior extremity, while the twelfth has neither.

32. Describe the manubrium sterni.

33. Mention the parts of which the sternum

is composed, and state at what points the costal cartilages articulate with each.

The sternum is composed of three principal portions: the manubrium, the gladiolus, or body, and the ensiform, or zyphoid cartilage; the body being transversely marked by three lines indicating the four segments of which it was originally composed. The first costal cartilage is connected with the upper part of the manubrium, the second articulates at the junction of the manubrium with the body, the third, fourth, and fifth at the extremities of the transverse lines that mark the body, and the sixth and seventh, usually together, at the junction of the gladiolus with the ensiform cartilage.

34. Describe the os Hyoides, and mention the muscles and ligaments connected with it.

35. Describe the clavicle. Mention its development, and the muscles which are attached to it.

36. Describe the portion of the clavicle external to the conoid tubercle.

In this question is required a description of the flattened extremity of the clavicle.

37. Give a description of the scapula, mentioning the bones with which it articulates, and its mode of development.

38. Describe (1) the lower end of the humerus as seen from before; (2) the same portion of bone as seen from behind.

The lower extremity of the humerus, as seen from before, presents from within outwards a projection, the internal condyle, which attaches pronator and flexor muscles; external to this, and projecting forwards, a smooth articular groove, the trochlear surface, concave from side to side, and convex from before back, its inner edge being much more prominent than its outer; above this a depression, the coronoid fossa; external to the trochlea, and separated from it by a slight groove, a rounded articular surface directed forwards, the capitellum, or lesser head of the humerus; lastly, the external condyle, a projection similar, though smaller than the internal, to which are attached supinator and extensor muscles. The objects seen from behind are, first, the back view of the internal condyle; external to this the posterior part of the trochlear groove, which is here very deep, and above it a deep depression the olecranon fossa; lastly, external to these, the back view of the external condyle, here much wider than in front, on account of the absence of any articular face for the radius on this aspect of the bone.

39. Mention, in their order, the grooves on the lower end of the radius, and the tendons corresponding to each.

The front of the lower extremity of the radius is slightly hollowed for the flexor tendons of the hand; on the outer surface are two slight grooves, the anterior of which corresponds to the extensor ossis metacarpi pollicis and the posterior to the extensor primi internodii pollicis; on the posterior surface, commencing externally, are first two shallow grooves, the external for the extensor carpi radialis longior, and the internal for the extensor carpi radialis brevior; next to this a small but distinct groove curving around a small but prominent tubercle for the extensor secundi internodii pollicis; lastly, a shallow groove for the tendons of the extensor communis digitorum and extensor indicis muscles.

40. Describe the connexions of the os magnum of the carpus.

The os magnum articulates by its upper surface with the semilunar and scaphoid; by its lower with the second, third, and fourth metacarpals; by its outer surface with the scaphoid and trapezium; and by its inner with the unciform. In front and behind it is rough for the attachment of the ligaments that bind it to the neighbouring bones, the anterior being in relation with the tendons of the deep flexor of the hand, and the deep palmar arch, and giving part origin to the flexor brevis pollicis; while the posterior is in relation with the radial extensor of the wrist, the extensor indicis, and the two outer tendons of the extensor communis digitorum.

41. How would you distinguish to what finger and to what side a metacarpal bone belonged?

In every metacarpal bone the anterior surface may be distinguished from the posterior on account of the former being concave, while the latter is straight, or slightly convex from above downwards. These being made out, its position may be easily known by the characters of its carpal extremity; of the five bones two only, third and fourth, have articular facets on both their lateral aspects; one, the first, or metacarpal bone of the thumb, has no lateral articular facets, and the other two, second and fifth, have lateral articular facets on one side only. The *first* is distinguished by its breadth and shortness, carpal articular facet concave from before back, convex from side to side, no lateral articular facets, outer surface presents rough tubercle for extensor ossis metacarpi pollicis. The *second*: carpal extremity prolonged internally into a process, carpal surface three facets for trapezium, trapezoid (for which the facet is large and is concave from side to side, and a little convex from before back), and os magnum: externally it has no lateral facet, while internally it has two. The *third*: carpal extremity prolonged into a process on its outer dorsal angle, carpal facet single and not so large as that of second, and not concave from side to side, two facets externally, and two internally. The *fourth*: carpal facet divided into two parts, internal large for unciform, external small for os magnum. Outer side has two facets, inner side one facet. The *fifth*: carpal facet single for unciform, one facet externally, non-articular on its internal aspect.

42. Describe the pelvic surface of the os innominatum, stating the points at which ligaments, fasciæ, and muscles are connected with this aspect of the bone.

In this question is required a description of only the pelvic aspects of the three portions, of which the innominate bone is composed; no mention is to be made of the borders or other part.

43. Describe the head and neck of the femur, and the trochanters major and minor in the child. What are the blood-vessels and nerves which supply them? Enumerate the changes which take place in these parts until old age.

The upper part of the femur of a child is composed of four parts, united by cartilage, there being one ossific centre for the head, one for each trochanter, and a fourth for the shaft, from which latter the neck becomes ossified. The number of these centres present would however depend upon the age of the child, as the centre for the head does not appear until the end of the first, and those for the greater and lesser trochanters not until the fourth and fourteenth years respectively. The trochanters unite with the shaft about the eighteenth, and the head about the nineteenth year. In the child and adult the neck forms with the shaft an obtuse angle; as life goes on the angle approaches more and more to a right angle; and in old age the head may even sink below the level of the trochanter major. At this period, too, the neck becomes shorter by interstitial absorption. Vessels are supplied to this part of the bone by the gluteal, sciatic, and internal circumflex arteries; and perhaps from the cotyloid branch of the obturator. A few twigs of nerve from the sacral plexus and great sciatic, together with sympathetic filaments, enter the bone with the arteries.

44. How may the side to which a patella belongs be distinguished? With what portions of the femur is it in relation (*a*) when the knee-

joint is completely flexed and (*b*) when it is in extreme extension.

The side to which a patella belongs may be known thus. Its anterior surface is non-articular; its apex points downwards; and the posterior or articular surface is divided into two unequal parts, of which the outer is the larger and concave transversely, while the inner is the smaller and is convex in the same direction.

When the knee joint is fully flexed, the patella articulates with the lower articular surface of the condyles of the femur, on which it lies obliquely, but in extreme extension it is drawn upwards, part being altogether above the articular surface of the femur.

45. Mention the lines that mark the shafts of the tibia and fibula, and state what structures were attached to them in the recent state.

The lines marking the shaft of the tibia are the anterior border to which is attached the fascia of the front of the leg; the interosseous ridge or external border, to which is attached the interosseous membrane; the internal border, to which the fascia of the back of the leg is connected, together with some fibres of the soleus muscle; the oblique line from which the soleus takes origin; and the vertical line, to which the special fascia that binds down the tibialis posticus is attached.

Those lines marking the fibula are the anterior external border, to which is attached the external intermuscular septum; the anterior internal or interosseous border for the attachment of the interosseous membrane; the oblique line or posterior internal border for the attachment of the fascia over the tibialis posticus, and the posterior external border, to which is connected the process of fascia that separates the muscles on the back from those on the outer side of the leg.

46. Give a description of the fibula, including its mode of development.

47. Describe the os calcis.

48. Mention the articulations of the cuboid and scaphoid bones, respectively.

49. What are the peculiarities of the second and fourth metatarsal bones.

The peculiarities of the second metatarsal bone are that it is the longest of the series; and that its tarsal extremity has on its inner side a single small facet for articulation with the internal cuneiform bone, while the outer has either four or else two, each divided by a vertical line into two parts, for articulation, two with the external cuneiform, and two with the third metatarsal bone. The peculiarities of the fourth are that the outline of its tarsal articular facet is quadrilateral, instead of three-sided; and that its tarsal extremity has, on its inner surface, a large facet divided by a vertical line into two parts, one for articulation with the external cuneiform, and the other for the third metatarsal bone, and on its outer a single surface for articulation with the fifth metatarsal bone.

CHAPTER II.

JOINTS, LIGAMENTS, AND FASCIÆ.

QUESTIONS on the articulations require mention to be made of the following points :—

1. The kind of joint.
2. The exact points of attachment of the ligamentous bands, if any, which bind the component bones together, commencing with the more superficial, and then proceeding to describe those more deeply situated.
3. A description of the number, and arrangement of the synovial membranes if any.
4. An enumeration of the motions of which the joint is capable, including the mode in which these are favoured or checked by the arrangement of the ligaments.

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1. Describe the osseous and ligamentous articulations between the occipital and other bones.

In this question it is required to give a description of the sutures of the occipital with the parietal and

temporal bones, mentioning the cartilage between the jugular surfaces; of the anchylosis in the adult with the sphenoid; and of the joint formed with the atlas. The ligaments connecting the occiput with the atlas and axis must be described seriatim.

2. Describe the joint between the skull and atlas, and between the atlas and the axis. Mention the movements possessed by each of them, their extent (range) and the means by which they are limited. Mention also the ligaments pertaining to each of these joints.

The joints between the occiput and the atlas, and between the atlas and axis are by articular surfaces, and synovial membranes, without the intervention of intervertebral discs. Between the occiput and atlas the joint is formed by elongated surfaces, nearer each other in front than behind, the upper, the condyles of the occiput, being convex in both directions and kidney-shaped, the lower correspondingly concave. The atlo-axoid articulation consists of, firstly, the odontoid process, a pivot joint, with two synovial membranes, one between its anterior surface, and the anterior arch of the atlas, and the second between its posterior surface and the transverse ligament which firmly binds the two pieces of bone against each other, the process being enlarged above its point of application so as to prevent vertical motion; and secondly, by a pair of flat articular facets on the contiguous portions of the bones. These last are provided with loose synovial membranes. By means of the occipito-atloidean articulation are performed the greater part of the nodding movements of the head; the range of movement is here extensive, being checked only by the somewhat lax anterior and posterior ligaments; the forward movement is limited in addition by the ligamentum nuchæ, and if nutation is carried further all the cervical vertebræ come into play. In this joint also a slight amount of lateral movement, or approximation of the head to the shoulder, can be effected, an action limited by bands between the transverse processes of the atlas, and the jugular processes of the occiput.

By means of the atlo-axoidean articulation, rotation of the head is effected, too great movement being prevented by the lateral check ligaments, and also by the ligaments uniting the first two vertebræ with each other.

Lastly is required an enumeration of the ligaments, first between the occiput and atlas, second between the atlas and axis.

3. Describe the temporo-maxillary joint; the movements of the lower maxilla, and the place of insertion on that bone of the muscles employed in mastication.

It is here required to give a description of the articulating surfaces of the bones and of the ligaments forming the joint. The movements of the bone and insertions of the muscles may then be proceeded with.

4. Describe the articulations of (*a*) the atlas with the axis; (*b*) the axis with the third cervical

vertebra; (*c*) the fifth lumbar with the first sacral vertebra.

5. Describe the articulation of the last dorsal vertebra with the first lumbar vertebra? What motions does this part of the vertebral column allow? Describe also the structure of the intevertebral substance and the ligamenta subflava.

In answering this question it should be remembered that the inferior articular processes of the last dorsal are similar to those of a lumbar vertebra.

The spine can be flexed and extended very freely in this part of the vertebral column, especially between the sacrum and the last two of the series where power of flexion is at its maximum. Considerable lateral bending can also be effected here, though not to such an extent as in the cervical region. Power of rotatory movement, however, is absent from this portion of the spine, because of the great breadth of the bodies.

The intervertebral discs.

The ligamenta subflava.

6. Enumerate and describe the ligaments which connect the spine and ribs.

7. Describe the articulations of the posterior end of the second rib with the spinal column—of the anterior end with the sternum—and of the osseous part of the rib with the cartilage.

The articulation of the vertebral extremity of the second rib, with the vertebral column, and of the sternal extremity with its cartilage, does not differ from that of the ribs in general, which should be described.

In the articulation of its cartilage with the sternum, however, there is, in addition to the fibrous capsule, with which these joints are provided, an interosseous ligament like that appertaining to the head of a rib, so that the joint is provided with two synovial sacs.

8. Write a description of the several structures that bind the innominate bone to the sacrum.

In this question is required a description of the sacro-iliac synchondrosis; the posterior and anterior sacro-iliac ligaments, and the greater and lesser sacrosciatic ligaments.

9. Give a description of the articulation of the symphysis pubis.

10. Describe the ligaments connected with the clavicle, and mention the parts which pass beneath it in their relative position.

Here is required a description of the ligaments connecting the clavicle with the sternum, the interclavicular, the rhomboid, the conoid and trapezoid ligaments, and those which secure its outer extremity to the acromion.

The parts that pass beneath it are from within outwards; the nerve to the subclavius, the axillary vein, the axillary artery, the cords of the brachial plexus, and behind the vessels the nerve to the serratus magnus.

11. Describe the coraco-clavicular ligaments,

and mention how they influence the motions of the scapula.

In this question is required a mention of the form and attachments of the two parts, conoid and trapezoid, of which the ligament is composed. Their use is to check too great rotation of the scapula.

Supposing the bone to rotate so as to move the acromion downwards, too extensive motion would be checked by the trapezoid portion; in the reverse direction it would be the conoid that would be put on the stretch. Were it not for these ligaments the scapula would be easily dislocated from the clavicle.

12. Describe under the following heads the anatomy of the shoulder joint:—

(*a*) The forms of the articular surfaces.
(*b*) The arrangements of the ligaments.
(*c*) The arrangement of the synovial membrane.
(*d*) The relations to the tendons of certain muscles.
(*e*) Its mode of vascular and nervous supply.
(*f*) Its movements.

13. If a patient has anchylosis of the os humeri with the scapula, state in what directions the shoulder can be moved. In what joint does motion take place?

What muscles move the shoulder?

Supposing the humerus to be immovably fixed to the scapula, all motions of the arm would have to take place by moving the scapula, either at its articulation with the clavicle, or together with that bone at the sterno-clavicular articulation.

Thus the arm could be abducted by rotating the scapula and lifting the collar bone; the former by means of the lower fibres of the serratus magnus, the rhomboideus minor, and levator anguli scapulæ; the latter by the trapezius.

The arm would be brought back to the side by the upper fibres of the serratus magnus, the rhomboideus major, the sub-clavius, the pectoralis minor, the pectoralis major, and latissimus dorsi, which latter two muscles would now become rotators of the scapula. A very slight forward and backward movement would also be possible; the scapula being rotated on its horizontal axis at the acromio-clavicular articulation by means of the greater pectoral and latissimus dorsi muscles.

14. (*a*) Describe the articular ends of the bones and the ligaments which compose the elbow-joint:

(*b*) State the attachments and relations of the muscles to these structures;

(*c*) State the arrangements of vessels and nerves which are in relation to, and supply the joint.

In this question is required a description of the elbow joint, and of the muscles and anastomoses around it.

15. Describe the connexion between the radius and the ulna, namely, the osseous surfaces of the joints, with the ligaments and membranes. Also

state the kind of movement which the radius describes at its upper, and at its lower ends.

Here are required description of the upper and lower radio-ulnar joints, of the annular ligament, the interosseous membrane and oblique ligaments; the lower radio-ulnar articulation with the triangular fibro-cartilage.

The upper joint is a lateral ginglymus, the bone rotating on its own axis; at its lower extremity the radius travels round that of the ulna.

16. What motions is the wrist-joint capable of performing? Show what ligaments respectively check these movements.

The movements of which the wrist-joint is capable are flexion, checked by the posterior ligaments; extension, by the anterior ligaments; abduction, by the internal lateral; adduction, by the external lateral ligaments, and circumduction or the successive employment of all the above four movements checked by the ligaments in opposition to each portion of its course.

17. Describe the structure, attachments, and uses of the anterior annular ligament of the wrist-joint. Enumerate the parts passing under, and mention their relative position.

The anterior annular ligament of the wrist is a thickening of the deep fascia by strong bands of transverse fibres, attached externally to the tubercle of the scaphoid and the ridge on the os trapezium and internally to the pisiform and the hook of the unciform. Its use is to change the direction of the force of the flexor tendons, by acting as a sort of pulley in the varied angles which the hand makes with the arm.

The parts that pass underneath it are the flexor tendons of the fingers and thumb, and the median nerve, the companion artery of the median nerve, and anastomosing twigs between the anterior carpal arch and the deep palmar arch.

18. Describe the carpo-metacarpal and the metacarpo-phalangeal joints of the middle finger; mention the movements possessed by each of these joints, and the muscles which are engaged in each movement.

The metacarpal bone of the middle finger forms with the os-magnum an arthrodial joint, lined with a process of the carpal synovial membrane. The ligaments connected with this joint are two dorsal bands, from the metacarpal bone to the trapezoid, and os magnum respectively, a single thin palmar band from the os magnum, an oblique band from the os trapezium, and a band from the os magnum and unciform to the ulnar side of the metacarpal bone.

The joint is capable of a slight forward and backward gliding movement, communicated indirectly to the joint by the muscles that flex and extend the finger.

The metacarpo-phalangeal articulation is formed by the convex head of the metacarpal bone and the concave upper extremity of the first phalanx, the bones being bound together by two lateral and an anterior ligament. It is capable of forward and backward and of lateral movement.

Flexion of this finger is performed by means of the flexor tendons, and lumbricales extension by the extensor tendon, the lateral movements outwards by the second, and inward by the third dorsal interosseous muscles.

19. Describe the structures which form the hip-joint, including the articular portions of the bones; give, in their relative order, the muscles, tendons, and bursæ, which lie in contact with it, and the vessels and nerves which supply it. What are the motions of which the joint is capable, and their effect upon the limb? Explain the use of the ligaments in checking and restraining them.

The structures forming the hip-joint are—

1. The head of the thigh bone, forming two-thirds of a sphere, covered with cartilage, which is thickest in its centre.

2. The acetabular cavity of the innominate bone, having a concavity of about half a sphere coated with cartilage, which is thickest at the circumference; in its inner margin is a notch, the cotyloid notch.

The acetabulum is deepened by means of a narrow slip of fibro-cartilage, the cotyloid ligament, which is triangular on section, and is fixed at its widest border to the margin of the acetabulum. This is continuous with a band of fibres called the transverse ligament which bridges over the cotyloid notch.

3. The capsular ligament strengthened by the ilio-trochanteric, ilio-femoral, and pubo-femoral bands.

The ligamentum teres running from the transverse ligament and sides of the cotyloid notch to a depression in the head of the femur a little behind and below its centre.

4. A synovial membrane lining the joint and reflected over the ligamentum teres.

Relations: In front psoas and iliacus separated from the capsule by a bursa.

Above: The reflected head of the rectus, and the gluteus minimus.

Behind the pyriformis, gemellus superior, obturator internus, and gemellus inferior. Beneath the obturator and gemelli is a bursa.

Below and internal: The obturator externus and pectineus.

Arteries, from the internal circumflex, obturator, sciatic and gluteal.

Nerves, from the obturator, accessory obturator, and sacral plexus.

Motions are flexion, extension, abduction, adduction, external and internal rotation, and circumduction.

Extension is checked by the ilio-femoral band.

Adduction by the ilio-trochanteric and lower slip of the ligamentum teres.

Abduction by the pubo-femoral band.

Flexion and external rotation by the ligamentum teres.

20. Describe the ligaments of the hip-joint, and mention the muscles in contact with its capsule.

21. Describe the arrangement of the fibres

which compose the anterior part of the capsular ligament of the hip-joint.

The anterior part of the capsular ligament of the hip-joint is the strongest part of the capsule, being strengthened by strong accessory bands, viz., the ilio-trochanteric, ilio-femoral, and pubo-femoral bands, which are blended with each other, and with this part of the capsule. The ilio-trochanteric extends from the ilium just below the point of origin of the reflected head of the rectus to the upper and anterior part of the trochanter major, and neck of the bone. The ilio-femoral is the strongest and is attached above to the anterior inferior spinous process of the ilium and below with the capsule to the anterior inter-trochanteric line; the pubo-femoral extends from the ridge of the pubes to the anterior and inner part of the neck of the thigh bone.

22. Describe the knee-joint.

(*a*) The articulating surfaces of the bones.
(*b*) The arrangement of the synovial membrane.
(*c*) The cartilages.
(*d*) The ligaments.

23. Describe the semilunar cartilages of the knee-joint, and their structure, form, attachment, and uses, and mode of action.

The points required in this question are their fibro-cartilaginous structure, their attachment, the processes to the crucial ligaments, form, &c. Their use is to deepen the hollow for the reception of the condyles of the thigh-bone, to lessen the pressure of the bones against each other, to diminish the effects of shock and in part to occupy a space which would otherwise be left during the change of position of the bones.

24. Describe the articular surfaces of the bones forming the ankle-joint, and the ligaments which connect them together.

25. Enumerate the ligaments which are connected with the lower end of the fibula, and their several bony attachments.

In this question is required a description of the ligaments interosseous, anterior, posterior, and transverse, as well as of the three bands of the external lateral ligament of the ankle-joint.

26. Mention the ligamentous connexions of the astragalus.

The astragalus is connected with the tibia, by the deep part of the internal lateral, and by the thin anterior and posterior ligament of the ankle-joint; with the fibula, by the anterior and posterior fasciculi of the external lateral ligament of the ankle; with the calcaneum by a stout interosseous band and by slight posterior and external ligaments; with the scaphoid bone by the dorsal astragalo-scaphoid ligament.

27. Describe the ligamentous structures and synovial membranes of the joints of the foot, between the tarsal and metatarsal bones, and state

how the several ligamentous bands will be brought into view in a foot from which all the muscles and the long plantar ligament have been taken away. Point out how the place of the tarsal end of each metatarsal bone can be ascertained on the dorsum of an entire foot on which the skin remains.

In the tarso-metatarsal articulations there are three synovial membranes; one for the first, one for the second and third, an extension of the tarsal synovial membrane, and one for the fourth and fifth.

The articulation of the metatarsal bone of the great toe with the internal cuneiform is furnished with a capsular ligament and with upper and lower longitudinal bands. To see the exact attachment of these bands and the synovial membrane, the ligaments should be cut through.

The ligaments connecting the four outer metatarsal bones with the tarsus are *dorsal*, one band for each, except the second, which receives fasciculi from each of the three cuneiform bones; *plantar*, one band to the second and third from the middle and external cuneiform bones respectively, and a few scattered bands from the cuboid to the fourth and fifth; oblique plantar fasciculi extend from the internal cuneiform to the second and third, and from the external cuneiform to the fifth metatarsal bone; the second and third metatarsals are provided with lateral ligaments which have a longitudinal direction. To see these ligaments the transverse ligamentous bands should be cut through, and the bones pulled somewhat apart; there are two for the second to the inner and middle cuneiform bones respectively, and a third from the external cuneiform bone to the outer side of the third metatarsal.

To mark out the position of these articulations the tuberosities of the fifth metatarsal and internal cuneiform bones should be felt for, and a line drawn across the foot so as to join them as far as the second metatarsal bone, whose articulation lies about a quarter of an inch behind this line, while that of the great toe is about a quarter of an inch in front of it.

28. Describe the metatarso-phalangeal articulation of the great toe, and the tendons in connexion with it, in their relative positions.

The tendons requiring description in this question are those of the flexor longus and brevis pollicis and of the extensor proprius pollicis, inner tendon of the extensor brevis digitorum, abductor pollicis, adductor pollicis, and transversalis pedis.

29. Name the joints in which interarticular fibro-cartilages occur, and describe the shape, the position, and the connexions of each fibro-cartilage.

The joints provided with interarticular fibro-cartilage are: the temporo-maxillary: cartilage oval, long diameter transverse, convex above, concave below, thinner at centre than circumference, connected by its circumference with the capsule and external ligament, and in front with the pterygoideus externus.

The sterno-clavicular: cartilage oval, flattened, thinner at centre than circumference, connected by its lower border with the cartilage of the first rib, by its upper with the clavicle.

The acromio-clavicular joint has occasionally an interarticular fibro-cartilage.

The triangular fibro-cartilage of the wrist a little concave below, connected by its base with the ridge separating the carpal from the ulnar articular surfaces of the radius, by its apex with the root of the styloid process of the ulnar, and by its anterior and posterior borders with the corresponding ligaments of the wrist-joint.

The semilunar fibro-cartilages of the knee-joint; the internal forms about two-thirds of an ellipse, exterior margin thick, interior thin, connected by its anterior extremities with the front and outer part of the internal facet of the tibia, by its posterior extremity with the hollow behind the spine, and by its circumference with the capsule. The outer forms a nearly complete circle, and on section is similar to the inner. It is connected with the spine of the tibia, between the terminations of the inner cartilage; it has less connexion with the capsule than the internal semilunar. Its anterior extremity is closely connected with the anterior crucial ligament, and a band is prolonged from its posterior extremity to the internal condyle along with the posterior crucial.

30. Enumerate the different kinds of movable joints, giving examples, and mentioning the movement of which each kind admits; describe the structure of the following component parts of movable joints, viz., ligament, synovial membrane, articular and non-articular cartilage.

The varieties of movable joints are :—

Arthrodial, which permit of a slight gliding movement, as the tarsal and carpal articulations ; ginglymus or hinge joints, which permit of flexion and extension, as the elbow and knee ; lateral ginglymus or pivot joints, which permit of rotatory motion as in the atlo-axoid ; and superior radio-ulnar articulations ; and enarthrodial or ball and socket-joints, which permit of flexion, extension, abduction, adduction, circumduction and rotation, as the shoulder and hip-joints.

Ligaments are composed of bands of compact fibrous tissue. Synovial membranes are thin closed sacs, formed of loose fibrous tissue, lined with a single layer of pavement epithelioid cells.

The articular cartilages are layers of hyaline cartilage covering the ends of bones where they come into contact. The non-articular cartilages that enter into the composition of movable joints are of the fibro-cartilaginous variety.

CHAPTER III.

MYOLOGY.

In describing a muscle the following points should be given:—

Shape and size, as round, flat, long, short, &c.

Proportion of tendinous and muscular structure.

Attachments to—either origin or insertion—1. Bones; 2. Ligaments; 3. Fasciæ.

Arrangement of the component fibres.

Action.

Relations.

Innervation, including the position at which the nerve pierces the muscle.

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1. Describe the attachments, action, and nerve supply of the oblique muscles of the eye.

It should be remembered, in answering this question, that the tendon of the superior oblique muscle is directed, after leaving the pulley, backwards, and outwards, to the posterior upper and outer part of the eyeball, so that rotating the eyeball it will direct the pupil downwards and outwards, whilst the inferior oblique inserting into the posterior lower and outer part causes the eye to look upwards and outwards. They counteract the action of the upper and lower recti, which being inserted at a point internal to the median line of the eye tend to draw it inwards.

2. Describe the muscles of mastication, the functions of each muscle, and the manner in which they are supplied with nerves.

3. Specify precisely the attachment of muscles to the occipital bone; and state by what nerve or nerves each muscle is supplied.

The muscles attached to the occipital bone are :—

Occipito-frontalis from outer half of superior curved line, supplied by the posterior auricular branch of the facial nerve.

Trapezius from inner half superior curved line by the spinal accessory nerve, third and fourth nerves (cervical plexus), and posterior branches of dorsal nerves.

Sterno-cleido-mastoid to outer third superior curved line below occipito-frontalis ; by spinal accessory nerve and external branch of second cervical (cervical plexus).

Splenius capitis, by a thin tendon below the superior curved line for about an inch ; by posterior branches of cervical nerves.

Complexus into inner two inches of space between curved lines, by posterior branches of cervical nerves.

Superior oblique to space between curved lines near mastoid process; by posterior branch of sub-occipital nerve.

Rectus capitis posticus major, to outer inch of inferior curved line, and surface below it; by posterior branch of sub-occipital.

Rectus capitis posticus minor, to space below internal third of inferior curved line; by posterior branch of sub-occipital nerve.

Rectus capitus lateralis, to under surface of jugular process; by anterior branch of sub-occipital.

Rectus capitis anticus minor, to under surface basilar process, a quarter of an inch from middle lines close to foramen magnum; by loop of first two nerves of cervical plexus.

Rectus capitis anticus major, to under surface of basilar process, in front of preceding muscle; by upper nerves of cervical plexus close to the vertebræ.

Superior constrictor of pharynx to spine of the basilar process, by pharyngeal plexus.

4. Describe the recti and obliqui muscles seen at the base of the skull and their functions. Also enumerate the vessels and nerves found in their immediate vicinity.

The vessels and nerves here alluded to are the vertebral artery, sub-occipital nerve, occipital artery, internal carotid, and ascending pharyngeal arteries, and upper part of cervical plexus.

5. Tabulate the muscles rotating the head, so

as to turn the face to the left side; and specify what nerve supplies each muscle.

Right sterno-cleido-mastoid	Nerve supply, see reply to question 3.
Right trapezius, its upper fibres	
Left splenius capitis	
Left complexus (outer fibres)	
Left rectus capitis posticus major	
Left obliquus inferior	Posterior branches cervical plexus.
Left trachelo-mastoid	

6. Describe the sterno-mastoid muscle, its situation, attachment, action, and relations to immediately surrounding parts.

7. The sterno-mastoid muscle:—*a.* name (without describing) the blood-vessels, and the nerves it covers, and the nerves which cross over it; *b.* mention the source from which it derives its nerve-supply; *c.* state the influence of the sterno-mastoid, supposing the muscle of one side only to be in action.

The sterno-cleido-mastoid muscle is superficial to the common and internal carotid arteries, internal jugular vein, first and second parts of sub-clavian vessels and several of its branches, occipital vessels, and the spinal accessory nerve, cervical cardiac, communicantes noni, and cervical and brachial plexuses, pneumogastric nerve and sympathetic twigs. It is crossed by the great auricular, transverse cervical, and supra-sternal branches of the cervical plexus, and by the external jugular vein.

One muscle acting alone draws the head downwards and forwards towards the same shoulder, rotating the face towards the opposite side.

8. Enumerate the muscles that are attached to the os hyoides.

9. Name the muscles of the larynx, giving the special action of each.

The muscles of the larynx are:—

Crico-thyroideus; action, makes tense the vocal cords.

Thyro-arytænoideus, relaxes the vocal cords.

Crico-arytænoideus posticus, opens the glottis.

Crico-arytænoideus lateralis, closes the glottis.

Arytænoideus. Transverse fibres close the glottis; crucial fibres slightly open the glottis.

Compressor sacculi laryngis, a few fibres which compress and empty the ventricle of the larynx.

10. The deep cervical fascia. Describe its extent, connexions, and arrangement; specifying particularly its relations to the muscles and blood-vessels of the neck.

The deep cervical fascia forms a continuous superficial sheath for the neck, from which processes are sent deeply between the muscles, and to form sheaths for vessels. Commencing in front, it gives sheaths to the muscles in front of the trachea, and next a sheath to the carotid artery, and internal jugular vein; this process is prolonged downwards on the innominate artery as far as the pericardium, and outwards on the subclavian vessels. Passing backwards, it splits to enclose the sterno-mastoid, and, meeting at the outer border of that muscle, again divides to enclose the trapezius, blending in the middle line behind with the ligamentum nuchæ. It is attached below to the sternum and clavicle, and above to the lower jaw, the zygoma, and the superior curved line of the occipital bones. It forms a covering for the parotid gland, and sends downwards between the parotid and submaxillary glands a strong band, the stylo-maxillary ligament. From the angle of the jaw there is sent a strong piece to the sterno-cleido-mastoid muscle. From the clavicle a process passes upwards to bind down the omohyoid muscle. Besides these processes dip in from the deep cervical fascia to form sheaths for all the muscles of the neck. The external jugular vein is superficial to the deep fascia, until it pierces it just above the clavicle.

11. Give a description of the intercostal muscles, their attachments, action, and nervous supply.

12. Tabulate the direct muscles of expiration and inspiration, without otherwise describing them.

The direct muscles of inspiration are, the diaphragm, external intercostal muscles, anterior part of internal intercostal muscles, serratus magnus, serratus posticus superior.

Those of expiration are, the posterior part of the internal intercostal muscles, the triangularis sterni, serratus posticus inferior rectus abdominis, and the flat muscles of the abdomen.

13. Describe the diaphragm, its attachments, relations on both surfaces, structure, and openings;

also state whence its blood-vessels and nerves are derived, and the mode in which they are distributed.

14. Describe the attachments, and the relations in front and behind the quadratus lumborum muscle.

15. The rectus abdominis muscle. Describe its position, its connexions, the peculiarities of structure, and the arrangement of its sheath.

The abdominal recti muscles are situated at the fore part of that cavity, one on each side of the middle line, being separated from each other only by the linea alba, and they extend in a vertical direction from the pubes to the thorax. Each is enclosed in an incomplete sheath formed of the tendons of the flat muscles of the abdomen, which are related to it thus. The aponeurosis of the external oblique passes completely in front of the rectus. That of the internal oblique, on arriving at the edge of the muscle, splits one lamina blending with the aponeurosis of the external oblique in front of the rectus, while the other passes behind it to blend in a similar manner with the aponeurosis of the transversalis muscle; but the posterior lamina does not extend lower than a point midway between the umbilicus and the pubes, below which all the aponeurosis passes in front of the muscle, so that the muscle here lies upon the transversalis fascia. The sheath is fixed to the margin of the thorax above, the rectus lying immediately on the ribs, thus it is deficient above and below. The rectus abdominis is crossed by tendinous intersections called lineæ transversæ. These rarely extend throughout the entire thickness of the muscle, being generally confined to its anterior fibres. They are generally three in number, one opposite the ensiform cartilage, one at the umbilicus, and a third midway between the other two.

16. Describe the attachments of the aponeurosis of the external oblique muscle of the abdomen, and the arrangement of its fibres.

The aponeurosis of the external oblique is thin above, and has its fibres directed transversely, the upper ones blending with the pectoralis major; lower down it increases in thickness, the fibres being directed downwards as well as upwards. They interlace with the fibres of the muscle of the opposite side at the middle line and assist to form the linea alba. The lowermost fibres are aggregated together to form 'Poupart's' ligament, which is attached externally to the anterior superior spine of the ilium, and internally spreads out to be inserted into the spine of the pubes, and into about an inch of the linea iliopectinea. This latter expansion is called 'Gimbernat's' ligament. Just above the crest of the pubes is an interval between the fibres, called the external abdominal ring, the margins or pillars of which are attached, the internal to blend with the tendon of the opposite side, the external with Poupart's ligament. Crossing the fibres in this region in the form of curves are the intercolumnar fibres. These are especially numerous near the upper part of the ring, and from them is prolonged a covering for the spermatic cord, the intercolumnar fascia.

17. Describe the form, the attachments, and

the functions of the following muscles, viz.: levator ani, sphincter ani, accelerator urinæ.

18. What are the muscles which contribute to effect the following movements of the upper extremity:—

(*a.*) Abduction at the shoulder-joint.
(*b.*) Extension at the elbow-joint.
(*c.*) Circumduction of the wrist-joint.

Give their exact points of attachment, the peculiarities in the disposition of their fibres, and their arterial and nerve supply. (The muscles of the digits are not required.)

(*a.*) The muscles effecting abduction of the shoulder-joint are: the outer fibres of the deltoid and the supraspinatus.

(*b.*) Extension at the elbow-joint is effected by triceps and anconeus.

(*c.*) Circumduction of the wrist-joint consists of the combinations and successive employment of flexion, extension, and the lateral movements; of these, flexion is effected by the radial and ulnar flexors of the wrist, extension by the two radial and the ulnar extensors, abduction by the extensor ossis metacarpi pollicis, also called the abductor manus, and adduction by the flexor and extensor carpi ulnaris acting together.

The exact attachment of the muscles is to be given.

Deltoid origin muscular; fibres arranged in coarse bundles, and cut into short lengths by the lattice-like tendinous intersections; insertion by a pointed short tendon. Nerve, circumflex; artery, anterior and posterior circumflex, acromial branches.

Supraspinatus.—Origin, muscular. Insertion, tendinous. Nerve, suprascapular. Artery, suprascapular.

Long Head of Biceps.—Origin by long round tendon; fusiform belly, blends with short head about its middle. Insertion by a tendon. Nerve, musculocutaneous. Artery, brachial.

Triceps.—Origin by three heads, scapular head by tendon, inner and outer heads by muscle. Insertion by flattened tendon. Nerve, musculo-spiral. Artery, superior profunda.

Anconeus.—Origin, tendinous, triangular in form. Insertion, muscular. Nerve, musculo-spiral. Artery, superior profunda and interosseous recurrent.

Extensor carpi radialis brevior.—Origin by common tendon, fusiform. Insertion, tendinous. Nerve, posterior interosseous. Artery, radial and posterior interosseous.

Extensor carpi ulnaris.—Origin by common tendon, and by aponeurosis to posterior border of ulna. Insertion, tendinous. Nerve, posterior interosseous. Artery, posterior interosseous and posterior ulnar recurrent.

Extensor carpi radialis longior.—Origin, fleshy, somewhat flattened. Insertion, tendinous. Nerve, musculo-spiral. Artery, superior profunda, radial recurrent, posterior interosseous.

Flexor carpi radialis.—Origin by common tendon, fusiform, becomes tendinous about middle of arm. Nerve, median. Artery, radial.

Flexor carpi ulnaris.—Origin, aponeurotic, flattened form. Insertion, tendinous into pisiform bone, some fibres passing over it to the base of the fifth metacarpal. Nerve, ulnar. Artery, ulnar and anterior ulnar recurrent.

19. Enumerate the muscles which connect the scapula with the trunk.

The muscles that connect the scapula with the trunk are, the trapezius, rhomboidei major and minor, pectoralis minor, serratus magnus, and levator anguli scapulæ.

20. Enumerate the muscles which elevate, and those which depress the acromion process.

The muscles that elevate the acromion are the trapezius, lower portion of serratus magnus, and clavicular part of the sterno cleido-mastoid. Those that depress it are the subclavius, pectoralis minor, rhomboideus major, upper part of serratus magnus, lower fibres of the pectoralis major, and latissimus dorsi.

21. The whole of the pectoralis major being removed, mention the various parts exposed, and their relative position.

Immediately below the clavicle is seen the costo-coracoid membrane, covering the subclavius muscle; crossing and piercing it, the cephalic vein, the acromial thoracic artery, and external anterior thoracic nerve. Still lower is the pectoralis minor with twigs of the inferior thoracic artery, and internal anterior thoracic nerve piercing it, and the long thoracic artery running along its lower border. Near the arm, the muscle lies upon the coraco-brachialis and biceps. The axillary vessels and brachial plexus are in contact with it below, but are separated from it above by the costo-coracoid membrane, and pectoralis minor. At its origin it lies upon the sternum, costal cartilages, ribs, and intercostal muscles.

22. The deltoid muscle. State its connection with bones (origin and insertion); name its principal artery and nerve; name also the parts which the muscle moves.

First give the origin and insertion. The principal artery and nerve to the deltoid are the posterior circumflex artery and circumflex nerve. It abducts the arm at the shoulder; it raises the arm slightly above the level of the scapula, and when the arm is raised the anterior fibres will draw the arm forwards, the posterior backwards.

23. Mention the several parts which are exposed to view on removing the deltoid muscle.

The deltoid muscle covers the shoulder joint, upper third of the humerus, between the head of which and the under surface of the muscle intervenes a large bursa; the insertion of the supraspinatus, infraspinatus, and teres minor; the upper part of the long and short heads of the biceps, and coracobrachialis, the insertion of the pectoralis minor, and the coracoid process, the posterior circumflex vessels and circumflex nerve.

24. State what muscle separates the teres minor from the teres major; describe the spaces left between the three muscles, and the vessels and nerves which pass through the spaces in question.

The muscle separating the teres major from the teres minor is the long head of the triceps. There are thus formed a quadrangular and a triangular space. The former is situated next the arm, and transmits the circumflex nerve, and posterior circumflex artery, while through the latter passes the dorsalis scapulæ artery.

25. Mention the muscles which surround the upper third of the radius and ulna, their relative positions, and the nerves supplying them.

The muscles surrounding the upper third of the radius and ulna are, from without inwards the supinator brevis, the biceps, the flexor longus pollicis, the brachialis anticus, pronator teres (small head); below these latter two, the flexor profundus digitorum; proceeding round the arm the flexor carpi ulnaris, anconeus, supinator brevis (origin), and below this the extensor ossis metacarpi pollicis. The branches of nerve supplying the muscles must be mentioned.

26. What are the two special pronators of the forearm? describe the attachments they have to bones, their relations to the muscles, vessels, and nerves of the forearm, and how the two muscles are supplied with nerves.

27. Give the attachments of the gluteus maximus, all the peculiarities of the muscle, and its functions. How is it supplied with blood and nerves?

28. Describe in their relative positions the parts exposed by removing the whole of the gluteus maximus.

The gluteus maximus covers internally, from above downwards, that part of the ilium above the superior curved line, the origin of the multifidus spinæ, the last piece of the sacrum, the coccyx, the great sacro-sciatic ligament, the tuberosity of the ischium, and the origin of the hamstring muscles. Externally it lies on the great trochanter, the upper part of the thigh bone, and the origin of the vastus externus, large bursæ intervening. Between these from above downwards are the gluteus medius, superficial part of gluteal vessels, pyriformis, sciatic vessels and nerves; the pudic vessels and nerve, the gemellus superior, obturator internus, gemellus inferior, quadratus femoris, a branch of the internal circumflex artery, and the uppermost fibres of the adductor magnus.

29. Specify precisely the place of attachment of each muscle, taking origin from the os innominatum, and the nerve or nerves supplying each muscle.

30. Enumerate the rotator muscles of the hip-joint and assign their several actions.

The external rotators of the hip-joint are gluteus maximus, gluteus minimus, pyriformis, gemelli, obturators, quadratus femoris, pectineus, and adductors, psoas and iliacus. The internal rotators are the tensor vaginæ femoris, and anterior part of the gluteus medius.

31. What parts are in *immediate* relation to (1) the obturator internus and (2) the obturator externus muscles.

The pelvic portion of the obturator internus is in immediate contact by its external surface with the obturator membrane, and the portion of the haunch bone from which it takes origin; and by its internal surface with the pelvic fascia, the origin of the levator ani, the obturator fascia, and the pudic vessels and nerves. It passes out of the pelvis, playing over the grooved surface of the ischium beneath the great sacro-sciatic ligament. Its gluteal portion is covered by the gluteus maximus, overlapped by the gemellus superior and inferior, and crossed by the sciatic vessels and nerves as they pass downwards. Between it and the capsule of the hip-joint is a synovial bursa.

The obturator externus is in contact by its anterior aspect with the pectineus, the adductor brevis, the inner and back parts of the capsule of the hip joint, and the back of the neck of the femur to the digital fossa. Its posterior aspect is in contact with the obturator membrane, the inner part of the margin of the thyroid foramen, the quadratus femoris, and gemellus inferior.

32. What are the muscles which flex the knee-joint? specify the origin and insertion of each; state also the source of the nerves supplying each, and the spot at which the fleshy fibres are pierced by the nerve in each case.

The muscles that bend the knee-joint are the semitendinosus, biceps, semimembranous, sartorius, gracilis, popliteus, and, the heel being fixed, the gastrocnemius and plantaris.

Before giving the nerve supply, the origin and insertion of each muscle is to be mentioned.

The hamstring muscles are supplied by the great sciatic, one or more branches of which pierce their anterior surface about the middle.

The branch of the anterior crural to the sartorius enters its deep surface in the lower part of its upper third, that to the gracilis from the anterior part of the obturator enters the upper part of its deep surface. The nerve to the popliteus from the internal popliteal winds round its lower border, and pierces its anterior surface; from the internal popliteal also is supplied the nerve to the gastrocnemius and plantaris; it divides into two branches, which pierce the upper parts of two bellies of the gastrocnemius, the outer giving a twig to enter the inner aspect of the plantaris.

33. Describe the popliteus muscle, and mention how it acts.

A full description of the muscle is here required. Action. It flexes the knee-joint, and rotates the leg inwards, occupying in flexion the groove on the outer condyle.

34. Describe in their relative positions the muscles, nerves, and blood-vessels which are brought into view by removing the gastrocnemius and soleus muscles.

In answering this question, it should be borne in mind that the plantaris muscle has not been removed.

35. (*a*) Group together, according to their action, the muscles which produce the movements of flexion, extension, inversion, and eversion of the foot.

The foot is flexed by means of the tibialis anticus, peroneus tertius and the extensors of the toes.

Extension is performed by means of the gastrocnemius, soleus, plantaris, tibialis posticus, peroneus longus, peroneus brevis, and the flexors of the toes.

Inversion is effected by the tibialis anticus and posticus.

Eversion by the peronei muscles.

36. Describe accurately the course of the tendons at the inner and outer ankle, and in the sole of the foot, their insertions and relations, and all the functions these tendons perform.

At the inner ankle the tendons are arranged thus: Innermost is the tibialis posticus, and next internal to this, the flexor longus pollicis.

The tibialis posticus tendon passes forwards over the internal lateral ligament, and the astragalo-scaphoid articulation to the tuberosity of the scaphoid bone.

The flexor longus pollicis crosses beneath the tendon of the flexor longus digitorum from without inwards, receiving a process from it, and passes forwards between the two heads of the flexor brevis pollicis.

The flexor longus digitorum in the foot is situated between the flexor brevis digitorum, and the deep layer of the muscles of the foot; it then divides into four slips which perforate between the two slips of each of the tendons of the flexor brevis digitorum. At the outer ankle are the peroneus longus and brevis, which pass through the same sheath, the long tendon being underneath.

The tendon of the peroneus brevis passes forwards along the outer side of the foot to the base of the fifth metatarsal bone, whilst that of the peroneus longus winds through a groove in the under surface of the cuboid bone, and crosses the sole of the foot through a sheath situated deeply to the base of the metatarsal bone of the great toe. The actions of the muscles to be described.

37. Give the origin and insertion of the following muscles, and state whence each derives its nervous supply—rectus femoris, plantaris, flexor longus digitorum, extensor brevis digitorum, and buccinator and stylo-pharyngeus; and state the exact relations of the above-named muscles.

38. On what form of lever do the greater part of the muscles act in moving the limbs? State the mechanical advantages and disadvantages resulting from the use of that form of lever. Give some of the best-marked instances of the sort in the human subject.

The majority of the muscles are so inserted as to act as levers of the third order, where the power is situated between the fulcrum and the resistance. They universally act at a very great mechanical disadvantage. The biceps, for instance, is inserted at about an inch and a half from its fulcrum, while the palm of the hand is about fourteen inches from it, so that to support in the palm one pound, the muscle would have to exert a force of about nine pounds. The advantage gained by this arrangement is increase of speed, so that, supposing the biceps to contract to the extent of one inch, the weight would be moved through nine inches. If the muscles were arranged at a greater mechanical advantage, an inconvenient length would be necessary in order to produce sufficient range of motion.

Flexion of the hip by the psoas and iliacus, temporo-maxillary, by the temporal muscle, flexion of the arm by the biceps, and of the knee by the hamstrings, are the most marked instances of the third class of lever.

CHAPTER IV.

NEUROLOGY.

THIS section contains questions on the nervous centres and the nerve cords.

In answering questions requiring the description of a nerve, the following points should be given :—

1. The point at which it takes origin from its parent trunk, or if a cranial nerve, the superficial, and deep parts of the brain with which it is connected.
2. Its course, and relations with surrounding parts.
3. The form and position of its termination.
4. Its branches, and their distribution whether to muscles or integument.
5. Its functions.

When the question is asked, 'What would occur if a certain nerve be injured?' the reply should contain an enumeration of the muscles, or sets of muscles, and the different surfaces to which it is distributed, with the statement that motion or sensation, as the case may be, would be lost in the parts mentioned, and therefore the function of the part would be in abeyance, muscles being paralysed or reflex actions prevented.

1. Name the commissures of the brain, and state the parts connected by each.

The commissures of the brain are of two kinds, transverse, and longitudinal. *The transverse commissures* :—The transverse bands of the corpus callosum connect the cerebral convolutions of opposite sides; the anterior commissure connects the corpora striata, and passes through both their intra and extraventricular nuclei into the substance of the hemispheres, where its filaments turn backwards for some distance towards the posterior cerebral convolutions; the posterior commissure joins the two optic thalami, and, having passed through them, extends outwards towards the lateral cerebral convolutions; the pons Varolii connects the lateral lobes of the cerebellum.

The longitudinal commissures:—The fornix, connecting the optic thalamus with the hippocampus major; the striæ longitudinales of the corpus callosum running along its upper surface, and passing with a prolongation of the covered band to the anterior perforated spot; the tænia semicircularis passing from the anterior pillar of the fornix to the white substance of the roof of the middle horn of the lateral ventricle. The fibres of the gyrus fornicatus, connecting the anterior perforated spot with the middle lobe of the brain; the fasciculus uncinatus, connecting the anterior with the middle and posterior lobes of the brain.

2. Describe the corpus callosum, and mention its connexions.

3. Name the parts connected by the following commissures in the encephalon: 'the fornix,' 'the anterior commissure,' 'the great superior longitudinal commissure,' and 'the soft commissure.'

See above, question 1. The soft commissure is not a true commissure, but merely results from the fusion of the two thalami optici, at the point where they come into contact with each other in the middle line.

4. Name in their order, from before back, the parts seen in the floor of the lateral ventricles.

The parts in the floor of the lateral ventricle are, from before back: a small part of the under portion of the corpus callosum; the intra-ventricular portion of the corpus striatum, or nucleus caudatus, the tænia semicircularis, the optic thalamus, and, lying on it, the choroid plexus, the posterior crus of the fornix, the commencement of the hippocampus major, the eminentia collateralis, and hippocampus minor.

5. What are the connexions of the cerebellum?

The cerebellum is situated in the posterior fossæ of the base of the skull, being overlapped by the posterior lobes of the cerebrum from which it is separated by the tentorium cerebelli.

It lies on the back of the encephalic peduncle to which it is connected below by the restiform bodies, and above by the processus e cerebello ad testes. The lateral lobes of the cerebellum are connected with each other by transverse fibres of the pons Varolii, which pass in front of the longitudinal bands of the peduncle.

6. Describe the superior and inferior medullary velum.

The superior medullary velum or valve of Vieussens is a thin lamina of white matter situated between the superior peduncles of the cerebellum, and forming the anterior part of the roof of the fourth ventricle. It is of triangular shape, the base being behind; its upper surface is marked by some grey transverse markings, and by the origin of the fourth pair of nerves.

The inferior medullary velum is a thin white layer, connecting the nodule of the inferior vermiform process to the flocculi on either side. It is crescent-shaped, attached behind to the transverse furrowed band, but free in front.

7. What are the appearances seen on making a transverse section of the medulla spinalis about its centre?

A transverse section of the medulla spinalis about its centre exhibits a nearly circular outline, but rather wider transversely than from before back; in front and behind are indentations corresponding to the median fissures; the anterior broad and shallow; the posterior, deeper and with closely approximated sides; laterally are depressions corresponding to the anterior and posterior lateral fissures.

Passing from one side to the other is the transverse commissure, in the centre of which, in early life, is a foramen lined with squamous ciliated epithelium, a section of the central canal.

With the exception of a narrow white band in front, the commissure consists of grey matter, and joins two lateral grey masses of crescent-shape. Each crescent has its convexity towards the middle line, the anterior horn being thick, rounded, and serrated, and entirely surrounded by white matter, while the posterior horn is thin and tapered, reaching to the posterior lateral fissure, close to which it enlarges a little to form the substantia gelatinosa.

The remainder of the section consists of white matter which is here less scanty than in the lumbar, but not so plentiful as in the cervical region of the cord.

Extending from the anterior lateral fissures to the anterior horn may be seen some striæ, which are the anterior roots of the nerves. The posterior roots, on the other hand, as seen by the naked eye, plunge directly into the substantia gelatinosa of the posterior horn.

8. Describe the course and distribution of the third cerebral nerve. What results occur from division of this nerve?

9. Trace the fourth and sixth cerebral nerves, from their origins to their terminations.

10. Give the origin, course, and distribution of the ophthalmic division of the fifth pair of nerves, and its branches.

11. Describe the course and relations of the superior maxillary branch of the fifth cranial nerve.

12. Describe the course, relations, and distribution of the temporo-auricular nerve.

13. What are the nerves found in the orbit? Mention the apertures through which each is admitted.

The nerves found in the orbit are:—

The second, or optic, entering at the optic foramen.

The third, motor oculi, entering at the sphenoidal fissure.

The fourth, patheticus, entering at the sphenoidal fissure.

The ophthalmic branch of the fifth, entering at the sphenoidal fissure.

The sixth, or abducens, entering at the sphenoidal fissure.

The temporo-malar of superior maxillary, entering at the spheno-maxillary fissure.

The sympathetic root of the lenticular ganglion, from the cavernus plexus, entering at the sphenoidal fissure.

Sympathetic plexus on the ophthalmic artery, entering at the optic foramen.

14. Give the origin, course, connexions, and distribution of the portio dura.

15. Give the distribution of the facial nerve.

16. Mention the various parts to which the pneumogastric nerves are distributed, and state

what are the functions supposed to be conferred on each of these parts by this distribution.

The pneumogastric nerves supply motor fibres to the muscles of the soft palate and pharynx, to those of the larynx, to the œsophagus and the stomach, and perhaps to the muscles of the bronchi, of the intestines, and of the uterus.

Inhibitory fibres to the heart.

Afferent fibres to the lungs, heart, and digestive tract.

It has been suggested that these nerves supply secretory fibres to the stomach and kidneys, and vasomotor branches to the pulmonary vessels.

17. Give the branches of the pneumogastric nerve in the order in which they are given off.

The pneumogastric nerve gives off from its upper ganglion, communicating branches to the spinal accessory, glossopharyngeal and sympathetic nerves, and an auricular branch (Arnold's); from its lower ganglion are given communicating branches to the ninth, sympathetic, and the loop between the first two cervical nerves; the pharyngeal, and superior laryngeal branches; next the superior cardiac, in the upper part of the neck; as the nerve leaves the neck the inferior cardiac: the inferior laryngeal is given off on the right side at the apex of the thorax, and on the left side somewhat lower down; in the thorax are given off thoracic cardiac, pulmonary, and œsophageal branches; having entered the abdomen the vagi terminate on the stomach, the left in front sending filaments also to the liver.

and the right on the posterior surface sending filaments to the cœliac plexus and spleen.

18. Describe the origin, course, distribution, and functions of the spinal accessory nerve, and its branches.

In giving the functions of the spinal accessory nerve, it should be remembered that most of the motor fibres of the pneumogastric are in all probability derived from it.

19. Give the origin and intra-spinal relations of the spinal accessory nerve.

The intra-spinal relations of the spinal accessory.—It ascends from the level of the sixth cervical nerve, to the foramen magnum within the dura mater lying between the ligamenta denticulata, and the posterior roots of the nerves.

20. Describe the course, distribution, and functions of the hypoglossal nerve.

21. Describe the origin of the nine cerebral nerves, and name the foramina by which they leave the cranium.

22. Enumerate the nerves which supply the iris, and their several functions.

The iris derives its nerves from the long ciliary branches of the nasal from the fifth, and from the short ciliary branches of the lenticular ganglion, through which it receives branches from the fifth, third, and sympathetic.

Contraction of the pupil is effected by means of the branches of the third; section of the sympathetic is followed by contraction of the pupil, so it has been conjectured that dilatation is in part effected by their means; the fibres of the fifth are afferent or sensory.

23. Describe the ganglia found about the head and face, their situations and relations, the sources whence they derive motor, sensitive, and sympathetic branches.

The ganglia referred to in this question are lenticular, spheno-palatine, otic, and sub-maxillary.

24. Enumerate the sensory and motor roots of the otic, spheno-palatine and submaxillary ganglia, and trace them from their several sources.

25. Describe the otic ganglion, its position, relations, communications with other nervous centres, and branches of distribution.

The nervous centres with which the otic ganglion is connected are:—The sensory nucleus of the fifth, through the root from the auriculo-temporal nerve; the motor nucleus of the fifth, through the root from the branch to the pterygoideus internus; the nucleus of the glosso-pharyngeal, and the intumescentia gangliformis of the facial through the small superficial petrosal nerve.

26. Describe the superior cervical ganglion of the sympathetic, its form, situation, and connexions. What effects result from its section?

The result of section of the superior cervical ganglion would be dilatation of the internal carotid artery and its branches, contraction of the pupil, and increased lachrymal secretion.

27. Describe the brachial plexus, from its origin to the clavicle.

28. State the sources from which the heart is furnished with nerves; mention the position and connexions of the cardiac plexuses, and the manner of the distribution of their branches to the heart.

The nerves of the heart are derived from ganglia imbedded amongst its fibres, from the cervical and upper thoracic sympathetic ganglia, and from the pneumogastrics and their recurrent laryngeal branches.

The superficial cardiac plexus is situated beside the ductus arteriosus below the arch of the aorta, and is connected with the left superior cardiac of the sympathetic, the left inferior cardiac of the pneumogastric, and with the deep cardiac plexus. From this plexus, and the branches it receives from the deep plexus, a plexus of nerves passes to the right coronary artery, and is distributed along its branches to the heart.

The deep cardiac plexus is situated behind the arch of the aorta, between it and the trachea, above the branches of the pulmonary artery; it receives the remaining cardiac branches of the sympathetic and vagus, and sends branches along the pulmonary artery to the auricles, and posterior or left coronary plexus. Each half of the plexus sends branches to the anterior coronary plexus.

29. Describe the thoracic portion of the sympathetic nerve, and the distribution of its branches.

30. Describe the splanchnic nerves; giving an account of their formation, course, relative anatomy, and distribution.

31. Give the formation, arrangement, and communications of the lumbar plexus, and indicate briefly the course and distribution of its branches.

32. Classify and enumerate the branches of the lumbar plexus of nerves.

	Motor	Sensory	Articular
Ilio-hypogastric	To abdominal flat muscles	To skin of buttock and abdomen	
Ilio-inguinal	Ditto.	To skin of groin	
Genito-crural	To cremaster	To skin of upper part of thigh	
External cutaneous		To skin of outer part of thigh	
Anterior crural	To muscles of front of thigh	To skin of front of thigh and inner side of leg and foot	
Obturator	To muscles of inner part of thigh	To skin of inner part of thigh	To hip and knee joints
Accessory obturator	To pectineus		To hip joint

33. Trace the circumflex nerve from the brachial plexus, and mention its distribution.

34. Trace the trunk of the musculo-spiral nerve, and enumerate the muscles to which its branches are distributed.

35. If the musculo-spiral branch of the brachial plexus of nerves were divided in the centre of the axilla, name the muscles which would be paralysed, and describe the position which the forearm and hand would assume.

On account of the paralysis of the extensor and supinator muscles, the unopposed flexors and pronators would cause the forearm to be bent on the arm, and the hand to be pronated and flexed ("drop hand").

36. Give the origin, course, distribution, and relations of the interosseous nerves.

37. Name the muscles which are supplied by the median and ulnar nerves respectively, and mention the digital branches which are given from each of those nerves.

38. Give the distribution of the ulnar nerve.

39. Describe the course and distribution of the obturator nerve.

40. State the origin, course, and distribution of the superior gluteal nerve. How does the last differ from that of the gluteal artery? What actions in common do the muscles supplied by it possess?

The distribution of the superior gluteal nerve differs from that of the artery in that it has no branch corresponding to the superficial portion of the latter.

The muscles supplied by it, viz., gluteus medius and minimus, and tensor fasciæ femoris, all assist in abducting the thigh; the anterior part of the gluteus medius and the tensor fasciæ femoris are both internal rotators; the posterior part of the gluteus medius, and the gluteus minimus, are external rotators.

41. From what spinal nerves does the great sciatic arise? describe its course, relations, branches, and distribution.

The great sciatic nerve, being a continuation of the sacral plexus, arises from the fifth lumbar and first four sacral nerves.

42. Give the course, relation, and distribution of the external popliteal nerve.

43. Describe the course, relations, branches, and distribution of the posterior tibial nerve.

44. Give a comparison of the nerves of the leg and foot, with those of the forearm and hand, pointing out the main points of agreement and difference.

Of the nerves that divide, to supply the leg and foot, the external popliteal corresponds to the musculo-spiral, and the internal popliteal to the median and ulnar. The external popliteal or peroneal, like the musculo-spiral, divides into two terminal branches, of which, in each case, one passes to the opposite side of the limb, by winding round it through a muscle, and the other runs down its lateral aspect; the anterior tibial corresponding to the posterior interosseous, passing down the limb deeply, ends in a gangliform enlargement over the small bones, and the musculo-cutaneous, corresponding to the radial, at first overlapped by muscles, and afterwards becoming superficial, ends in digital branches. On the flexor aspect of the leg, unlike the arm, the nerves to the foot run down the limb as a single trunk, the posterior tibial corresponding to the median and ulnar, the anterior interosseous, of the arm, being represented in the legs by the deep muscular branches of the posterior tibial. It is not until the nerve arrives at the ankle-joint that it divides into the internal plantar corresponding to the divisions of the median, and the external plantar to the ulnar. In the palm and sole the similarity is much closer than anywhere else. In both, the median, or internal plantar, supplies the abductor and flexor brevis pollicis, two lumbricals, and the skin of the great digit, and the next two-and-a-half digits. There is, however, this difference, that whereas on the hand, only the outer part of the flexor brevis pollicis is supplied by the median, in the foot, the whole muscle is supplied by the internal plantar.

The external plantar, like the ulnar, supplies all the other muscles; and divides into a superficial and a deep branch, of which the superficial in each case runs forward to supply the remaining digit-and-a-half, while the deep runs across to supply the muscles.

45. Give the origin, course, and distribution of the following nerves:—1, glosso-pharyngeal; 2, hypoglossal; 3, internal pudic.

46. Describe the course and relations of the

nerves which supply the following muscles, tracing them from their origin to the part of the muscle at which they enter, subclavius, serratus magnus, obturator internus, pectineus, popliteus, and anconeus.

47. Describe a spinal nerve, its mode of origin, intra-spinal course, and general mode of distribution.

Origin of Roots
- Anterior
  - Outer to anterior and lateral columns
  - Middle—lost in anterior horn
  - Internal—cross in anterior commissure to opposite side of cord
- Posterior
  - By inner and outer fasciculi from the posterior horn, many fibres becoming longitudinal.

Intra-spinal course.—Anterior roots arise irregularly from the side of cord; posterior, in a straight line. Each posterior root is provided with a ganglion close to its junction with the anterior root.

The roots are separated from each other by the ligamenta denticulata, and, joining together in the intervertebral foramina again, immediately divide into two trunks.

Distribution
- Anterior trunk
  - Cutaneous
  - Muscular
- Posterior trunk
  - External
  - Internal
    - Cutaneous & Muscular.

CHAPTER V

ANGEIOLOGY.

In describing an artery, mention should be made of the following points :—

1. The point at which it takes origin from the parent trunk.
2. Its course and the superficial parts to which it corresponds.
3. Its mode and region of termination.
4. Its relations.
5. Its branches and their distribution.

When this question relates to a vein, the corresponding points should be noticed, but the description should commence with a mention of the radicles from which it arises, its connection with the main vein being given as its termination. The position or absence of valves should also be mentioned. The relations of a vessel should be given, precisely as they are seen in a dissection, mentioning how and where they come into contact with the vessel, and not enumerated in a list on its four sides.

1. Describe the arch of the aorta, the parts

into which it is divided, and their position and relations.

2. If a ligature be applied to the arteria innominata, how will the right arm and the right side of the head and neck obtain their supply of arterial blood?

The parts will be supplied with blood by the following collateral circulation:—Internal mammary anastomosing with the deep epigastric, aortic intercostal and phrenic arteries.

Superior intercostal, superior thoracic, acromial and long thoracic, and subscapular with aortic intercostals.

Spinal branches of vertebral and of ascending cervical with spinal branches of aortic intercostals.

Posterior scapular with posterior branches of intercostals.

Inferior thyroid with fellow of opposite side.

Internal carotid with that of the opposite side in the circle of Willis.

Vertebral with opposite vertebral in the basilar trunk.

Branches of the external carotid, viz., superior thyroid, lingual, facial, occipital, pharyngeal, temporal, and internal maxillary with those of the opposite side.

3. Give the course, relations, branches, and anastomoses of the internal mammary artery.

4. Name the relations of the left subclavian artery, in its first stage.

5. Describe the coronary sinus of the heart.

6. Describe and contrast the right and left venæ innominatæ.

The description of these vessels will be found in any text-book. The points of difference occur in consequence of the superior vena cava being situated on the right side of the sternum. The right vein is therefore short, and nearly vertical in direction, the left is three times as long, and almost horizontal, crossing behind the sternum in front of the three great branches of the aorta.

7. Describe the course and relations of the vena azygos major; what veins contribute to form it?

8. Describe the position and relations of the cœliac axis.

9. Enumerate in their order the branches of the hepatic artery and their inosculations.

10. Describe the arteries which encircle the stomach.

The arteries which encircle the stomach are:—

(1) The gastric running first to the œsophageal orifice, and then along the lesser curvature, giving branches on both sides, which anastomose towards the left extremity of the stomach, with the vasa brevia of the splenic. It terminates by inosculating with the pyloric branches of the hepatic and right gastro-epiploic. (2) The right gastro-epiploic of the gastro-duodenal of the hepatic, running behind the commencement of the duodenum, and then along the greater curvature to join (3) the left gastro-epiploic of the splenic, which completes the circle, by anastomosing with (4) the vasa brevia of the splenic.

11. Describe, in the order in which they occur, the anastomoses of the arteries on the walls of

the alimentary canal, from the cardiac orifice of the stomach to the anus.

For the chain of arteries around the stomach see above, question 10. The chain of anastomoses continues. The gastro-duodenal of the hepatic divides into two branches, the right gastro-epiploic, and the superior pancreatico-duodenal which anastomoses above with the superior and inferior pylorics, and below with the inferior pancreàtico-duodenal of the superior mesenteric. The last inosculates with the first of the vasa intestini tenuis. The vasa intestini tenuis, generally more than a dozen in number, are supplied to the small intestine; they form arches with each other, from the convexities of which are given off branches which in turn form smaller secondary arches, and these, again, others. Ultimately the branches are distributed in small twigs to the small intestines. The last of the vasa intestini tenuis anastomoses with the ileo-colic, the terminal branch of the superior mesenteric. The ileo-colic anastomoses with the right colic, the right colic with the middle colic, and the middle colic with the left colic of the inferior mesenteric. The left colic anastomoses with the sigmoid, and the sigmoid with the superior hæmorrhoidal. The superior hæmorrhoidal anastomoses with the middle hæmorrhoidal of the internal iliac, and finally the middle hæmorrhoidal with the inferior hæmorrhoidal of the internal pudic.

12. Trace from its origin the gastro-duodenalis artery and its branches.

13. Trace the spermatic arteries to their termination.

14. Describe the lumbar branches of the aorta, and their distribution outside the spinal canal. Give also the arrangement of the branches inside the spinal canal in a fully injected body.

The spinal branches enter the canal alongside the nerves, and after giving off a twig which runs with the nerve to supply the cauda equina, and its membranes, divide into two branches, one ascending and the other descending, to join corresponding branches of the spinal artery next above and below. The arches thus formed send twigs across the posterior surfaces of the vertebræ to join corresponding twigs from the opposite side, and thus a central median artery is formed, and its size maintained throughout the spinal canal.

15. Describe the course and relative situation of the external iliac artery in the male adult. Describe also the epigastric branch of the artery, its origin, course, anastomotic communications. Mention also its relative situation with respect to the internal and to the external abdominal rings, and to the inguinal canal.

16. Describe the course, and give the relations of the internal epigastric artery.

17. Describe the course and relations of the veins which terminate in the inferior vena cava above the junction of the common iliac.

18. Enumerate the veins which join the inferior vena cava.

19. Compare the common carotid arteries of the two sides.

On the right side the carotid trunk arises from the innominate, while on the left it springs directly from the arch of the aorta. On this account the right carotid has no intra-thoracic portion analogous to the first part of the left common carotid. At the root of the neck there is an angular interval between the right carotid and its internal jugular vein, while that of the left lies in contact or even in front of the artery.

20. Describe the course and relations of the right subclavian artery, and state the difference which exists between it and the left.

21. Describe all the varieties in the course of vessels to be remembered in performing the operation of tracheotomy.

The following are some of the peculiarities in the course of the vessels about the root of the neck, which may give rise to danger in the operation of tracheotomy:—

The arch of the aorta may be placed as high as the upper border of the sternum. The right subclavian artery may be given off after the left carotid, and may then cross the root of the neck in front of the trachea.

The left carotid may be given off from the innominate, and so cross the root of the neck to its destination.

There may be an arteria thyroidia ima, a small branch which occasionally arises from the innominate within the thorax and, ascending in front of the trachea, is distributed to the thyroid body.

22. Trace the supra-scapular artery from its origin to its termination.

23. Describe the course and mention the relations and branches of the cervical stage of the facial artery.

24. Give the course and relations of the internal maxillary artery, with the several stages assigned to that vessel.

25. Mention the course and relations of the ophthalmic artery.

26. Enumerate the arteries which supply the brain. What is remarkable in their course before they reach the brain, in their connexions with each other, and in their final ramifications? What reason can you assign for their peculiarities?

Before reaching the brain these vessels take many sharp curves with the result of diminishing the force of the blood current. When entering the skull the walls are thinned, owing to the loss of their sheath, and in part their external coat. Within the skull the communication between these vessels is extensive, the vertebrals uniting to form the basilar artery, whose divisional branches assist in the formation of the circle of Willis, by which complete anastomosis the supply of blood in the two sides of the brain is equalised. The subdivisions of the arteries divide and anastomose freely with each upon the surface, forming minute twigs upon the pia mater, from which the vessels pass into the brain structure at a right angle, so that, in the vessels which enter the brain, pulsation is greatly diminished, if not entirely lost.

27. Give the origin, course, and distribution of the arteries supplying the hemisphere of the cerebrum; and the origin, course, and ending of the

veins returning the blood, from the same half of the brain.

28. State the origin and course of the vertebral arteries, and their distribution within the cranium. Describe also the mode in which the circle of Willis is formed.

29. Give a description of the thyroid veins.

30. What is the relation of the external jugular vein to the cervical fascia in the different parts of its course?

The external jugular vein lies at first between the platysma and the deep fascia. At the lower part of the neck, after it has crossed the sterno-mastoid muscle, it pierces the deep fascia to join the subclavian vein.

31. How does the external jugular vein differ from other cervical veins?

After the external jugular vein has crossed the sterno-mastoid muscle, it becomes dilated, so as to form a sinus. This dilatation is limited by two pairs of valves, one pair of which are placed just below the edge of the sterno-mastoid muscle, while the other pair are situated at its junction with the subclavian vein.

32. Give an account of the origin, course, and termination of the axillary artery, and the connexion of the vessel, and of its principal branches with the adjoining parts.

33. Enumerate and describe the branches of the brachial artery.

34. Mention the anastomoses that take place around the elbow joint.

Anterior ulnar recurrent with anastomotica minor.

Posterior ulnar recurrent with inferior profunda, and anastomotica magna.

Radial recurrent with the external branch of superior profunda.

Interosseous recurrent with the internal branch of superior profunda.

A free lateral anastomosis also takes place upon the posterior ligament of the elbow joint.

35. Give the course, relations, and distribution (including anastomoses) of the ulnar artery.

36. Describe the formation, course, and relations of the superficial and deep palmar arches.

37. Give a description of the arrangement of the veins at the bend of the elbow.

38. When the femoral artery is tied above the origin of the profunda femoris, by what channels does the blood reach the lower extremity?

By the following anastomoses—

Ascending branches of external circumflex with gluteal and circumflex iliac.

Transverse branches of external circumflex with gluteal and with sciatic.

Anterior branches of internal circumflex with obturator.

Posterior branches of internal circumflex with sciatic.

Articular branches of internal circumflex with obturator.

First perforating of profunda with sciatic.

If the artery is ligatured above the origin of the superficial epigastric, superficial circumflex iliac, and superficial pudics, they would assist in the collateral circulation, the first two anastomosing with their corresponding deep branches, and the last with the superficial perineal arteries from the internal pudic.

39. Give the course and relations of the profunda femoris; name its branches, and trace out the course of the internal and external circumflex arteries; and state the anastomoses they form in the neighbourhood of the hip-joint.

40. Describe the situation of the arteria profunda femoris, trace its branches, and give their distribution and anastomoses.

41. Describe the muscular relations of the profunda femoris artery.

42. Describe the relations and branches of the popliteal artery.

43. What are the relations of the posterior tibial artery in the leg?

44. Enumerate the branches of the anterior tibial artery, and give its muscular relations in the leg.

45. Describe the course, relations, and termination of the external plantar artery.

46. Give the course and relative connexions and inosculations of the principal arteries of the leg and foot, commencing at the origin of the tibial arteries.

The arteries requiring description are the anterior tibial, dorsalis pedis, posterior tibial, peroneal, external and internal plantar arteries.

47. Name the structures subservient to the circulation of the blood in fœtal life, which, after birth, lose their functions and remain as vestiges. Describe the position and character of each (vestige) in the adult.

The temporary structures subservient to the fœtal circulation are :—

1. Foramen ovale, represented in the adult by the fossa ovalis on the inter-auricular septum.

2. Eustachian valve, which in the adult is only a narrow flap of endocardium.

3. The ductus arteriosus, which becomes the ligamentum arteriosum, a fibrous cord joining the commencement of the left pulmonary artery with the contiguous part of the aortic arch.

4. The left superior cava vein, which in the adult forms the vestigial fold of the pericardium, descending obliquely in front of the left auricle.

5. The ductus venosus, afterwards a fibrous cord in the posterior part of the longitudinal fissure of the liver.

6. The umbilical vein, which remains as the round ligament of the liver.

7. The hypogastric arteries, which become two fibrous cords running from the superior vesical arteries to the umbilicus.

48. Describe the relations, structure, and functions of the various valves met with severally in the heart, arteries, and veins, and state in which veins valves are absent.

Valves are structures interposed in the blood current so that it can only move past them in one direction. In structure they are commonly said to be reduplications of the lining membrane of the vessels, but this is not absolutely correct. The valves of the veins are composed of fine connective tissue, with stellate and fusiform cells, the internal elastic layer of the veins covering only their convex surface. The valves of the heart are composed of two parts, a fibrous and an elastic, the fibrous stratum being continuous with the fibrous rings of the base of the heart, while the elastic is derived in the case of the arterial valves from the lining membranes of the ventricles, but in the venous from the endocardium of the auricles. The valves of the heart are the bi- and tricuspid or auriculo-ventricular, formed of flat flaps of membrane, held down on their ventricular aspect by fine tendons attached to papilla-like processes of the muscular substances of the heart. The only valves found in the arteries are the semilunar valves, found at the commencement of the aorta, and pulmonary artery. These are three pocket-like flaps, provided at the centre of their free edge with a fibro-cartilaginous nodule, the corpus Arantii.

Most of the veins, especially those that run in the muscular parts, are provided with valves composed of one or two, or even three, pouch-like flaps. The veins unprovided with these structures are, the innominate, superior cava, inferior cava (unless the Eustachian valve be mentioned); the hepatic veins, the portal vein, and its radicles, the renal veins, the veins of the diploe, the venous plexuses of the spinal canal, and the part of the spermatic veins contained within the abdominal cavity.

CHAPTER VI.

ORGANOGRAPHY.

THE various parts to which the questions of this section refer are so diverse that no general directions or scheme for answering them can be given, beyond what has been said in the preface to this work.

1. Describe the dura mater in the cranium: and mention its structure and uses.

The dura mater of the skull is of a fibro-elastic structure; it is the outermost of the membranes of the brain, and acts as a periosteum to the interior of the cranium.

It is closely applied to the skull bones, but most adherent at the base, where prolongations are sent into the various foramina, and at the foramen magnum it is continuous with the dura mater of the spinal cord. It is lined on its internal surface with the parietal layer of the arachnoid.

It is folded in along the line formed by the lateral sinus, and superior petrosal sinus as far as the anterior clinoid processes, with a deficiency in front, to form the tentorium cerebelli. It is also folded downwards along the line of the superior longitudinal sinus, to form the falx cerebri, a lamina narrow in front and broad behind, where it blends with the tentorium. In the lower free margin of this fold is the inferior longitudinal sinus. Below the tentorium is a similar smaller fold, the falx cerebelli. Between the layers of these folds are venous channels or sinuses.

2. Give the arrangement and structure of the membranes of the spinal cord.

The spinal cord is enclosed in three membranes, the dura mater, the arachnoid, and the pia mater. The *dura mater*, a fibro-elastic membrane, is continuous above, with that of the brain, through the foramen magnum, and below the first lumbar vertebra it is prolonged as a fibrous cord, to be attached to the fibrous tissue on the back of the coccyx. It is not applied to the bones forming the canal as a periosteum, a quantity of cellular tissue and vessels intervening, but it is considerably larger than the spinal cord. It is lined on its inner surface with the parietal layer of the arachnoid. It sends prolongation upon the nerves as they perforate it.

The *arachnoid* is an extremely thin serous sac, the parietal layer of which is adherent to the dura mater, while a considerable interval, the sub-arachnoid space, intervenes between the visceral layer and the cord; it forms reflections on the nerves, and ligamenta denticulata, so that no structure perforates its cavity.

The *pia mater* is a vascular membrane, somewhat rough on its outer surface, which closely ensheathes the cord, sending a reduplication into the anterior median fissure, and furnishing sheaths to the roots of the nerves; laterally it sends out triangular processes in the intervals between the inter-vertebral foramina, the apices of which are connected with the dura mater; these are called the ligamenta denticulata.

3. Describe the form and dimensions, in its different parts, of the vertebral canal, enumerate its contents, and give a description of the structure and uses of the membranes of the spinal cord.

The spinal canal is largest in the cervical region, where it is triangular in form, smallest, and nearly circular, in the dorsal region; intermediate in size, and triangular, in the lumbar region, while in the sacral region it is flattened from before back, and at the lower extremity is not protected by bone posteriorly.

4. Give a description of the cornea.

5. Describe the structure, connexions, and relations of the iris; trace, from their origin to their distribution, its arteries and nerves.

The iris is a circular curtain which divides the anterior region of the eyeball into chambers. It has a nearly central circular aperture, the pupil, through which light reaches the retina, and by which the chambers communicate. Until the seventh month of fœtal life there is no pupil, because the membrana pupillaris occupies its destined position.

The posterior surface is in contact partly with the ciliary processes, and partly with the crystalline lens. The intervening space, which varies very much in capacity, is the posterior chamber. In early life there is scarcely, if any, such space, therefore there is very little or no chamber. The anterior surface corresponds in extent to the cornea. The intervening space is the anterior chamber. The chambers are filled with the aqueous humour.

The circumference of the iris is much thinner than the rest of it, and is bent backwards over the bodies of the ciliary processes, to be attached to the ciliary muscle. By this arrangement the main portion of the curtain falls in a plane about $\frac{1}{20}$th of an inch anterior to the line of its attachment, and when the pupil is contracted, and the iris thereby stretched, the ciliary processes are pushed backwards against the crystalline lens.

The chief portion of the circumference of the iris, its middle layer, is incorporated with the ciliary muscle, and is composed of areolar and elastic tissue, blood-vessels, and nerves, but no muscular fibres. The anterior layer is continuous, through the ligamentum pectinatum iridis, with the posterior lamina of the cornea, and is composed of membrana limitans supporting epithelial cells. The posterior layer, also composed of membrana limitans with epithelial cells, and thick dark brown pigmentary matter is continuous with the corresponding structures of the ciliary processes.

On the anterior surface of the iris ridges radiate from the pupil. These are most apparent near the pupil. They are produced by puckering consequent on contraction of the sphincter muscle, and are less evident when the pupil is dilated.

Structure.—The iris is mainly composed of involuntary muscular fibres, intermixed with elastic fibres.

Upon its anterior surface is a single layer of squamous epithelial cells, intermixed with some pigment, upon which the 'colour of the eye' depends. Beneath the cells is a fine homogeneous layer, with which the epithelium is connected. Upon its posterior surface are many layers of cells, nearly spherical, or containing and surrounded by a large quantity of pigmentary granules. Beneath these also is a homogeneous layer. The anterior and posterior homogeneous layers, together with their covering epithelium, are continuous, as has been explained, with corresponding tissues upon the cornea, and upon the ciliary processes. The intermediate portion is composed of muscular and elastic fibres, of areolar tissue, and of vessels and nerves.

The muscular fibres are of the pale or involuntary class. They have a circular and a radiating form. The circular, in large bundles, are chiefly around the pupil, and constitute its sphincter. There are, besides, two or three small circular bands at intervals from the sphincter. The radiating fibres are arranged in fine fasciculi, intermingled with elastic fibres.

The elastic fibres, also radiate, are numerous, very distinct, dark in outline, and wavy. The elasticity of the iris is due to them.

The blood-vessels supplying the iris, large and numerous, are derived from the circular chain at the posterior margin of the ciliary muscle. In their course they run through the ciliary muscle. They proceed towards the pupil without anastomosis, then divide, communicate laterally, and form a circular anastomosis.

The veins of the iris correspond to the arteries. They pass parallel with the arteries through the ciliary muscle, and are lost in the veins of the choroidea.

The nerves of the iris are derived from the ciliary nerves. Short ciliary branches from the lenticular ganglion, twelve in number, perforate the sclerotica near to the optic nerve. Two long ciliary branches from the ophthalmic nerve also perforate the sclerotica in front of the former. All pass towards the ciliary muscle, between the sclerotica and the choroidea. The short ciliary twigs give branches to the vessels of the choroid coat. Before arriving at the ciliary muscle, a division and an inosculation of all ensue. From this plexus branches pass into the cornea, and through the ciliary muscle into the iris, where they run towards the pupil, dividing and communicating with each other. As soon as they enter the iris their outline becomes indistinct.

6. Give the position, attachment, and functions of the ciliary muscle. Describe its microscopic structure.

The ciliary muscle is a circle of involuntary muscular fibres, about $\frac{1}{11}$th of an inch in length, from before, backwards, situated at the circumference of the iris. An antero-posterior section shows the muscle to be of a triangular form, with the base forwards. Exteriorly, that is, superficially, it is in contact with the sclerotica; interiorly, it rests on the ciliary processes. Anteriorly, at its base, it is attached to the iris, and posteriorly, at its apex, it is continuous with the choroid.

It arises from the median fasciculi of fibres from the posterior elastic lamina of the cornea. The fibres pass backwards. The deeper strata, about one-third the length of the superficial, curve round to insert into the base of the ciliary processes. The other strata pass with grades of obliquity backwards, to insert two-thirds into the connective tissue of the ciliary processes, and the remaining third consisting of the most superficial and longest fibres, into the connective tissue of the choroid coat.

Müller describes, in addition to the antero-posterior fibres, a belt of circular muscular fibres situated near the circumference of the iris, the existence of which is questionable.

Within the ciliary muscle are numerous blood-vessels and nerves, which, together with connective tissue, come from the choroid coat. Through the ciliary muscle must pass all vessels, as well as nerves, which go to the iris, and to the ciliary processes, so that, upon the contraction of the muscle must greatly depend the quantity of blood supplied to, or existing in those parts. Now since the ciliary processes consist chiefly of blood-vessels, it follows that they are capable of undergoing great variations in size, according to the quantity of blood they contain, and therefore of exerting a pressure upon the margin of the lens. A pressure upon the margin would render its poles more convex, and so regulate the accommodation of the eye. It is generally supposed that this muscle accommodates vision by drawing forward the suspensory ligament, and so enabling the lens by its own elasticity to increase its bi-convexity.

7. Mention the objects seen on the inner or deep surface of the retina.

The retina is thin and translucent so that the pigment of the choroid shows more or less through it. It ends in a finely serrated border, called the ora serrata. In its centre is an oval yellow spot, the macula lutea, in the centre of which is a depression, the fovea centralis. A little to the inner side of this is a slight elevation, the porus opticus, where the optic nerve enters, and radiating from its centre are the retinal vessels.

8. Describe the crystalline lens, its position, relation to contiguous parts, connexions (how it is held in its place), and structure. State also the use of the lens in vision.

The crystalline lens is a nearly circular, biconvex disk, contained within its capsule, which closely invests it.

The posterior surface is the more convex of the two, and lies within the lens fossa, or excavation in the vitreous body.

The anterior surface, the flatter, with the suspensory ligament intervening, lies in contact with the bulbous extremities of the ciliary processes, which overlap its equator, and with the iris, which, when accommodated for near vision, it slightly pushes forwards. Its pole corresponds to the centre of the pupil.

The lens is kept in position by the vitreous body, the posterior capsule being attached to the hyaloid membrane, and by the suspensory ligament, which is connected with the anterior capsule.

Structure.—When a lens is boiled it becomes pearly-white and hard, from the coagulation of the albumen which enters into its composition, and it will now readily separate in concentric laminæ or in planes. An extension of the boiling will cause either the laminæ or the planes to separate into shreds, which are the lens fibres.

If a lens be carefully examined, both surfaces present three lines radiating from the centre or pole to the circumference or equator, as though dividing the surfaces into three triangles. The lines of the one surface do not, however, correspond to those of the other surface, but lie in an intermediate position. These lines may be recognised, in a normal lens, during life, by oblique illumination.

The lens fibres are considered to be tubules of protein in early life, but afterwards to become solid.

They have numerous nuclei connected with them, and their cut extremities are hexagonal. The fibres of each lamina are all about the same length. Some commence from the centre or pole, others from the radiating lines. All pass over the equator to the opposite surface, but their terminations differ. Those which commenced at the pole extend to a point but just over the equator, whilst those which commenced from the lines extend in graduation further and further over the equator, till the lowest approaches the opposite pole. It is owing to this arrangement that the radiating lines of the two surfaces do not correspond, but alternate in position.

The lens possesses no blood-vessels, but receives its nourishment through the fluids, with which it comes in contact.

Nerves are not distributed to it.

Use.—The lens focuses upon the retina near or distant objects by increasing or decreasing its biconvexity.

9. Describe the lacrymal organs, viz., the gland, its position, connexions, ducts, and nerve, also the excretory apparatus—the position, size, and structure of its several divisions.

The lacrymal gland is almond-shaped, situated beneath the external angular process of the frontal bone, and lying upon the eyeball and the external rectus. It is supplied by the sympathetic and lachrymal nerves. From the gland emerge six or eight small ducts, which pass down the back of the eyelid to open in a row above the outer canthus; two, however, open below the canthus.

The apparatus for excreting the tears is situated at the inner canthus. Near to the inner canthus are two small openings in the eyelids, the puncta lacrymalia. These are the orifices of the lacrymal canals, minute hair-like tubes, which at first run vertically, and then after a sudden bend converge together, to open close to each other into the lacrymal sac. The sac is a small pouch occupying a groove in the lacrymal bone and continuous with the nasal duct below. The duct becomes narrower as it descends in the bony canal formed by the superior maxillary, lacrymal, and inferior turbinated bones, and terminates in the inferior meatus of the nose, the opening being guarded by an imperfect valve.

10. Describe the anatomy of the eyelids and explain their functions.

The eyelids are two movable integumental folds, which guard the front of the eyeball. They are supported by thin fibro-cartilaginous plates, the tarsal cartilages, of which the upper is the larger, and more semicircular in form.

On their inner surfaces the eyelids are lined by the conjunctiva, between the skin and which are certain muscles, glands, &c., appertaining to the part, in such order that, in dissecting from the skin, one meets with:—Orbicularis muscle, some loose cellular tissue, the palpebral ligament, (in the upper lid) the tendon of the levator palpebræ, the tarsal cartilage, the Meibomian glands, and the conjunctival lining. The principal functions of the eyelids are to protect the eye from violence or from too intense a light; to evenly distribute the tears, over the front of the eyeball, by the action of winking, for the purpose of moistening the eye and washing away foreign material. In connection with the eyelids are the ciliæ or lashes, which, protruding from the lids, are first influenced by particles of matter, such as dust, etc., approaching the eye, and, by a reflex action, cause their immediate closure.

11. Describe the membrana tympani.

The membrana tympani is a fibro-elastic membrane, almost circular, attached by its edge to the groove at the bottom of the external meatus. It is somewhat concave externally, and is composed of three layers, the external continuous with the lining of the meatus, the internal with the mucous membrane of the tympanum, and the middle, or membrane proper, which is composed of radiating fibres, strengthened at the circumference by strong circular fibres, together with vessels and nerves. The handle of the malleus is attached to the point to which the radiating fibres converge.

12. Describe the boundaries of the cavity of the tympanum. Enumerate the parts found therein.

The boundaries of the tympanum are:—

Externally. The membrana tympani, and some surrounding bone.

Internally. The elevation of the canal which contains the facial nerve, and the parts of the internal ear, which are indicated by the promontory and fenestræ rotunda and ovalis.

Behind. The mastoid cells, and their openings; and in the lower internal angle, the pyramid.

In front. The carotid canal, and the openings of the Eustachian tube, and canal for the tensor tympani muscle.

Above. A thin plate of bone separating it from the cranial cavity.

Below. The jugular fossa.

The tympanum contains the osseous chain, formed by the malleus, incus, and stapes, and the tendons of the stapedius and tensor, and laxator tympani muscles.

13. Describe the cochlea: 1, its osseous structure; 2, its membranous portion, and the structures connected with it, including the mode of distribution of the cochlear division of the auditory nerve.

The cochlea forms the anterior part of the labyrinth. It is shaped like a snail shell, the tube making two-and-a-half turns around a central column, the modiolus. Twisting round the modiolus, so as to partly divide the osseous tube into two, is the lamina spiralis, broad below, narrower above, and ending in the hamulus.

The membranous portion lines the osseous tube, and completes the lamina spiralis, so as to separate from each other the two scalæ—scala tympani and scala vestibuli—besides which the upper scale is divided into two by the delicate membrane of Reissner.

The lamina spiralis membranacea is composed of a superior lamina, the membrana tectoria, and an inferior, the membrana basilaris, which spreads out where it is attached to the outer wall of the cochlea to form the ligamentum spirale. Between these two laminæ is situated the organ of Corti.

The canal below the lamina spiralis is called the scala tympani, and communicates, by the foramen rotundum, with the tympanum, only a thin membrane separating it from that cavity.

The canal above the membrane of Reissner is called the scala vestibuli, and communicates below with the vestibule, and above with the scala tympani at the helicotrema.

The membranous cochlea (proper) is situated between the membrane of Reissner and the membrana basilaris; it is closed above, but below communicates indirectly with the saccule of the vestibule by means of a small duct, the canalis reuniens.

The cochlear division of the auditory nerve pierces the base of the modiolus, and gives off branches, which pass brush-like through the lamina spiralis ossea, to form the spiral ganglion, from which branches are sent to the organ of Corti.

14. Mention the bones and soft parts that form the septum of the nose.

The septum nasi is formed by the vomer, the perpendicular plate of the ethmoid bone, and by a small part of the nasal, frontal, superior maxillary, and palate bones where they meet the septum, by the triangular fibro-cartilage, and by a layer of mucous membrane on either side.

15. State the position which the heart and the arch of the aorta bear in reference to the walls of the thorax and to the lungs.

The heart is situated behind the lower two-thirds of the sternum, more than two-thirds of the organ lying to the left of the middle line. The upper limit of the auricles corresponds with a line across the sternum from the second right, to the first left, intercostal space. The right limit corresponds to a line curving a little to the right, drawn from the second right intercostal space to the fifth right costal cartilage, nowhere extending more than one-and-a-half inches to the right of the middle line.

The apex corresponds to a point just below the fifth rib, near its junction with its cartilage about three-and-a-half inches to the left of the middle line. The outline of the heart may be completed by drawing lines from the apex to the first intercostal space, and to the fifth right costal cartilage. The base of the heart corresponds to the interval between the fifth and eighth dorsal vertebræ.

The commencement of the aorta is situated behind the third left costo-sternal articulation. It then passes obliquely upwards, and to the right, until it reaches the level of the upper border of the second right costal cartilage; it then arches backwards, and to the left, to reach the left side of the body of the second dorsal, at its greatest height, being on a level with the middle of the manubrium sterni, and then descending terminates in the thoracic aorta opposite the lower border of the third dorsal vertebra.

The lungs are situated on either side of the heart, and great vessels, the front part of their inner surfaces being hollowed out to make room for it, especially the left. The descending portion of the arch would be in relation, however, with the *back* part of the left lung.

16. Describe the surfaces of the heart and the surfaces of the great vessels connected with it, so far as these are covered by the pericardium.

The heart is of conical form, somewhat flattened antero-posteriorly, and on its surfaces are circular and longitudinal sulci, indicative of septa which divide the organ into four cavities, two auricles above, and two ventricles below. The anterior surface is almost entirely formed by the right cavities, only a small portion near the left border being formed by the left. Close to the left border is the interventricular sulcus, and encircling the base the auriculo-ventricular sulcus, with branches of the coronary arteries running in them. The right ventricle close to the interventricular sulcus forms a cone-shaped process, from which arises the pulmonary artery. To the right of the pulmonary artery is the right auricle, and its ear-shaped appendage, receiving the termination of the superior vena cava. Springing up from behind the pulmonary artery and right auricular appendix is the ascending portion of the arch of the aorta. The commencement of both the aorta and pulmonary artery show the dilatations called sinuses of Valsalva. To the left of the pulmonary artery is the left auricular appendix.

The posterior surface of the heart is mainly formed by the left ventricle, a small portion only, near the right border, being formed by the other. In the posterior interventricular sulcus is a branch of the right coronary artery. Separating the auricles from the ventricles is the posterior auriculo-ventricular sulcus, containing branches of the right and left coronary arteries.

Above this are the auricles, of which a very large portion of the left, and a small part of the right are visible. Entering the left auricle are the pulmonary veins, and entering the right auricle the superior and inferior vena cava.

17. Mention the peculiarities of the fœtal heart.

There is a free communication between the two auricles by means of the foramen ovale.

The inferior vena cava is provided with a large and perfect 'Eustachian' valve, which directs the current of blood from that vessel across the right auricle to the foramen ovale.

The right ventricle is thicker in proportion to the left than in the adult.

It is considerably larger in proportion to the weight of the body than in the adult, especially during the earlier periods of development. Up to the fourth month the heart is vertical instead of oblique in position.

18. Describe the cartilages, ligaments, muscles, and nerves of the larynx, and their several uses in reference to the production and modulation of the voice.

The cartilages of the larynx are the epiglottis, thyroid, cricoid, arytenoid, the cornicula laryngis, and the cuneiform cartilages.

The cartilage of the epiglottis is shaped like a daisy-leaf. It is formed of yellow elastic cartilage, and is placed in an erect position at the front of the larynx, so as to be pressed down over the glottis by the food during deglutition.

The thyroid cartilage forms the front and lateral walls of the larynx. It is formed of two nearly flat alæ, united in front at an acute angle. Each ala is somewhat quadrilateral in form, its posterior border being continued above and below as the superior and inferior cornu.

There is a deep notch where the superior borders meet in front.

The cricoid cartilage is placed below the thyroid. It somewhat resembles a signet ring, the broad part being behind and projecting upwards.

The arytenoid cartilages are two small three-sided pyramids, having their bases articulating with a facet on the upper border of the thick part of the cricoid.

Each arytenoid cartilage has a small tubercle in front of its base for the attachment of the true vocal cord, and another one at the side for the attachment of the crico-arytenoideus lateralis and posticus.

The cornicula laryngis are two small conical cartilages of the yellow elastic variety situated upon the apices of the arytenoid cartilages.

The cuneiform cartilages are small pieces of cartilage placed in the thyro-aryteno-epiglottic fold of mucous membrane, near the apex of the arytenoid cartilage.

The ligaments which bind these cartilages together are as follows:—

Thyro-epiglottic—some fibrous bands which bind the stem of the epiglottis to the retiring angle, between the alæ of the thyroid.

Thyro-hyoid—a wide membrane bounded laterally by two rounded cords, attached below to the superior border of the thyroid cartilage, and its superior cornua, and above to the superior and posterior border of the os hyoides and its great cornua.

Crico-thyroid. The articulation between the inferior cornua of the thyroid and the sides of the cricoid is provided with a small capsular ligament, beside this the two cartilages are united together by means of the crico-thyroid membrane. This is composed of elastic tissue and consists of a middle and lateral portions; the middle portion is of triangular form with its base below, and is attached to the contiguous borders of the two cartilages; the lateral pass from the inner lip of the upper border of the cricoid cartilage upwards, to end in a free margin stretched across from the angle of union of the alæ of the thyroid cartilage to the anterior tubercle of the arytenoid cartilage constituting the true vocal cords. The true cords are also called the inferior thyro-arytenoid ligaments.

Thyro-arytenoid superior—a few bands contained in the false vocal cords.

Crico-arytenoid, a small capsular ligament for each articulation.

For muscles of the larynx and their functions, see Chap. III., Q. 9.

The nerves of the larynx are the superior and inferior laryngeal, of which the former supplies the crico-thyroid by means of its external laryngeal branch and part of the arytenoideus muscle, together with the chief part of the mucous membrane of the larynx; the latter supplies the remaining muscles and small part of the mucous membrane.

19. State the position and connexions of the vocal cords (true); name the muscles which have influence on them; and describe the position, the connexions (origin and insertion), and the action of each muscle upon the cord.

20. Describe the form, course, and structure of the adult trachea, and mention its relations to contiguous parts.

The trachea commences at the lower border of the cricoid cartilage, opposite the fifth cervical vertebra, and terminates by bifurcating into the two bronchi, opposite the third dorsal vertebra.

It is composed of a fibro-elastic membrane, which is prevented from collapsing by sixteen to twenty horseshoe-shaped cartilages, placed in front and on the sides of the tube, its posterior aspect being flattened and membranous. It is lined with a mucous membrane provided with ciliated columnar epithelium.

In the neck it has in front of it the thyroid body, and the sterno-hyoid and sterno-thyroid muscles; on each side the common carotid arteries, and recurrent laryngeal nerves; behind the œsophagus. In the thorax it has in front of it the manubrium sterni, the origins of the above muscles, the left innominate vein, the origins of innominate and left carotid arteries, and the arch of the aorta. On either side are the right and left pleura, and pneumogastric nerves. Behind it is the œsophagus.

21. State the differences between the right and left lungs.

The right lung is the heavier, shorter, and broader, and has three lobes, whereas the left has two, on account of the position of the heart, the inner surface of the left lung is more hollowed out than the right for its reception.

22. Enumerate the parts in contact with the left pleura.

In contact with the left pleura are: with its visceral layers, the left lung; with its parietal layer, the vertebral column; the ribs and intercostal muscles of the left side and intercostal vessels; the sternum; the left sympathetic chain; the diaphragm; the arch of the subclavian artery; the commencement of the left carotid artery; the left pneumogastric, phrenic, and cardiac nerves; the trachea and œsophagus; aorta; pericardium.

23. Describe the structure and functions of the soft palate, including the anatomy of the muscles connected with it, and the arteries and nerves supplying it.

The soft palate is a reduplication of mucous membrane forming a partition between the mouth and pharynx, and prolonged downwards in the middle line to form the uvula, enclosing muscular and tendinous fibres, glands, &c. It is attached in front to the posterior border of the hard palate, and below is connected by two prominent folds of the mucous membrane to the tongue and pharynx respectively; connected with it are the following muscles, the anatomy of which is to be given:—The levator and tensor palati from above; the palato-glossus in the anterior pillar of the fauces, and palato-pharyngeus in the posterior pillar; descending into the uvula in the middle line, the azygos uvulæ.

The component structures are arranged from behind forwards as follows:—

Nasal mucous membrane; posterior slip of palato-pharyngeus; azygos uvulæ; levator palati; anterior slip of palato-pharyngeus; tensor palati; palato-glossus; buccal mucous membrane.

The arteries supplied to the soft palate are—

The posterior or ascending palatine of facial; superior or descending palatine from the internal maxillary.

The palatine branches from the lingual.

The palatine branches from the ascending pharyngeal.

Its nerves are derived from the superior maxillary and glosso-pharyngeal.

The use of the soft palate is to serve as an inclined plane during the passage of the food from the mouth to the pharynx; to prevent the food passing up into the nose; to direct the nasal secretion into the pharynx; and to direct the current of air through the nose or mouth during respiration, or in sneezing, coughing, &c. It takes also an important part in articulation.

24. Describe the tonsils: their form, position, connexions with adjacent parts, structure, and uses.

The tonsils are two glandular structures, about the size and shape of an almond, situated above the root of the tongue, between the anterior and posterior pillars of the fauces. External to each is the superior constrictor of the pharynx, which alone intervenes between it and the internal carotid artery.

The free surface of each tonsil presents about twelve orifices which lead into recesses in its substance. Into each of these recesses there open a number of small follicles lined by processes of the mucous membrane of the throat. The walls of these secondary follicles are thick and contain a number of closed capsules filled with retiform connective tissue, and being very similar to the solitary Peyer's glands of the intestine.

The functions of the tonsils are at present little known; probably they secrete a glairy fluid, having the object of lubricating the food as it passes through the fauces.

25. Describe the course and relations of the œsophagus; describe also its structure and functions.

The œsophagus commences at the termination of the pharynx opposite the lower border of the fifth cervical vertebra, and terminates, after passing through the diaphragm, in the stomach, opposite the ninth dorsal vertebra. It has in its course three curvatures: an antero-posterior, corresponding to that of the spinal column, and two lateral; commencing at the middle line it passes somewhat to the left at the root of the neck, and regains the middle line about the level of the fifth dorsal vertebra, and lastly bends forwards and to the left to reach the œsophageal opening of the diaphragm.

In the neck, it has in front of it the cricoid cartilage and the trachea; behind is the vertebral column, and on the side the carotid sheath and its contents.

In the thorax the œsophagus has in front of it the lower part of the trachea, the commencement of the left bronchus and the pericardium; behind it are the spinal column, longus colli muscle, the thoracic duct; and, in the lower third, the aorta. On the right side it is in contact with the vena azygos and the right pleura, on the left with the left pleura, and in the upper part with the aorta. The vagi nerves descend on either side forming a plexus round it, the left nerve coming gradually to the front while the right passes to the back.

The œsophagus is constructed of an outer muscular layer of external longitudinal and internal circular involuntary muscular fibres; a middle areolar, and an internal mucous coat. Its function is to convey the food from the mouth to the stomach.

26. Give a description of the form, position, and connexions of the stomach.

The stomach is a somewhat conical dilatation of the alimentary canal, the axis of the cone forming a curve, with its concavity upwards. Thus the stomach has a large end or fundus, and a small end or apex, a lesser curvature concave, and a greater curvature convex. The œsophagus joins its upper border about one-third from the greater end. The stomach is situated in the left hypochondriac, epigastric, and right hypochondriac regions, the apex or pyloric extremity reaching on the right towards the neck of the gall bladder, while the cardiac or great cul de sac is placed to the left, and touches the spleen. With the lesser curvature of the stomach is connected the lesser or gastro-hepatic omentum, with its fundus the gastro-splenic, and with its greater curvature the gastro-colic or great omentum; its anterior

surface is in relation with the under surface of the liver, the diaphragm, and the abdominal wall in the epigastric region; the posterior surface is in relation with the pancreas, aorta, vena cava inferior, the solar plexus, and the pillars of the diaphragm. When the stomach is empty its surfaces are directed forwards and backwards; when full, owing to the attachment of its upper curvature, the surfaces are directed upwards and downwards.

27. Give the divisions of the duodenum, and the length, position, and relations of each; mention the ducts which open into it.

The duodenum is divided into an ascending, vertical, and inferior or transverse portion.

The *ascending portion* is about two inches long, and extends from the pylorus to the neck of the gall bladder. In front is the liver, and behind the lesser omentum, with the bile duct and portal vein. It is completely surrounded by peritoneum. The *vertical portion* is about three inches long, and descends from the neck of the gall bladder to the level of the third lumbar vertebræ. In front of it is the hepatic flexure of the colon; behind the right kidney, to its inner side, the head of the pancreas and the hepatic duct, it is covered by peritoneum, in front only.

The *inferior or transverse portion* is about five inches in length, and extends to the left side of the second lumbar vertebra. In front of it are the superior mesenteric vessels and the transverse colon; behind are the aorta, vena cava, left renal vein (occasionally), and the crura of the diaphragm. The transverse

meso-colon divides in front of it, the one part passing upwards and the other downwards. The ducts that end in the duodenum are the ductus communis choledochus and the pancreatic.

28. Mention the divisions of the small intestine. State the length of each of the portions, and the naked-eye characteristics by which they may be distinguished from each other.

The small intestine is divided into duodenum jejunum and ileum. The entire length of the duodenum is about ten inches, divided into three portions (see Q. 27 above). The jejunum measures about eight, and the ileum about twelve feet in length. The duodenum commences at the pylorus, and its termination is marked by being fixed firmly in position by a fibrous band from the left crus of the diaphragm, valvulæ conniventes are seen in the lower half, and they are stained by bile. The jejunum is larger and thicker than the ileum, owing to the greater size of its valvulæ conniventes. In the ileum on the side opposite to the attachment of the mesentery may be seen Peyer's patches. There is, however, no distinct line of demarkation between the jejunum and ileum.

29. Describe the cæcum and ileo-cæcal valve. What are the points of difference that distinguish the large from the small intestine?

The cæcum is a cul de sac at the commencement of the large intestine. It is about two and a half inches long, and about the same in width. Connected with the lower and back part of the cæcum is the vermiform appendix, on which commence the three longitudinal muscular bands of the large intestine.

The ileo-cæcal valve consists of two folds of mucous membrane placed at the junction of the ileum with the cæcum. The upper fold is placed with its plane nearly horizontal, while the lower is nearly vertical; together they form a slit-like opening, the direction of which is nearly transverse to the axis of the cæcum. At each end of the aperture, the two folds unite to form a ridge, which extends for a short distance round the cavity of the intestine; these ridges are called retinacula.

The iliac surface of the valve is covered with villi, but the cæcal aspect is unprovided with them.

30. Describe the connexions of the lower four inches of the rectum in the male, the naked-eye character of the coats of the gut for the same distance, and the precise arrangements of its arteries, veins, and nerves.

The lower four inches of the rectum extend from about the lower border of the third piece of the sacrum to the anus. Its upper part is covered with peritoneum on the front and sides, lower on the front only, while the last inch and a half, being beyond the fold of the recto-vesical pouch, has no connexion with the peritoneum.

In front of it are Douglas's pouch, the trigone of the bladder, the entrance of the ureters, the vesiculæ seminales, and vasa deferentia, the prostate gland, and the bulb of the urethra. Behind are the sacrum, coccyx, and for the lower inch, the skin and cellular tissue; the origin of the external sphincter, and the posterior part of the insertion of the levatores ani intervening. On each side are the coccygeus and levator ani suspending it, as in a sling. About the lower inch and a half of the rectum, there is much granular fat, and its extremity at the anus is embraced by the sphincters. The muscular coats of the lower part of the rectum are thick and vascular, the longitudinal fibres forming an uniform layer to prevent the rectum from becoming sacculated. The longitudinal fibres cease near the end of the gut, but the circular are much thickened and there form the internal sphincter. The mucous membrane is thicker and more vascular than that of the colon, and is freely movable on the muscular coat.

The arteries of the lower part of the rectum are derived from the inferior and middle hæmorrhoidals; they pierce the muscular coat, and taking a longitudinal direction run to the end of the gut, where they form an anastomotic ring by means of transverse branches.

The numerous veins communicate freely, following generally the arrangement of the arteries. The nerves are derived partly from the sacral plexus and partly from the inferior mesenteric, and hypogastric plexus of the sympathetic, the latter following the course of the vessel.

31. Describe the liver as to form and relations. How is it retained in its position?

In form the liver is somewhat square, presenting four borders and two surfaces. The posterior border is thick and rounded, while the anterior forms a thin sharp edge. The right border is much thicker than the left. The upper surface is smooth and convex, and divided into two parts by an antero-posterior fold of peritoneum. The under surface is concave and uneven, and divided by five fissures into five lobes.

The fissures of the liver are—

Longitudinal, extending from before backwards and dividing the right from the left lobe. It contains the round ligament of the liver.

Transverse, extending half across the right lobe at right angles to the longitudinal fissure.

Fissure for the ductus venosus, a continuation of the longitudinal fissure backwards beyond the transverse fissure.

Fissure for the vena cava, in the posterior border of the right lobe.

Fissure for the gall bladder, extends from before back, from the anterior border of the right lobe nearly to the transverse fissure.

The lobes of the liver are the right and left, divided by the longitudinal fissure, but the right is subdivided into three smaller lobes, viz., the

Lobulus quadratus, situate between the longitudinal, transverse and cystic fissures.

Lobulus Spigelii, between the longitudinal, transverse and caval fissures.

Lobulus caudatus, joins the lobulus Spigelii to the main body of the right lobe, intervening between the transverse and the termination of the caval fissures.

The liver is placed in the right hypochondriac, epigastric, and left hypochondriac regions. It is in relation above with the diaphragm, and below with the gall bladder, stomach, duodenum, hepatic flexure of the colon and the right kidney and suprarenal body.

It is retained in position by certain folds of peritoneum, called ligaments.

These are the coronary, passing from the posterior border to the diaphragm, two lateral ligaments or folds, of which the left is the most distinct, situated at the extremities of the coronary ligament, and the falciform or suspensory ligament passing from the upper surface to the diaphragm and abdominal walls, and containing in its anterior or free margin, between its layers, the obliterated umbilical vein, or round ligament.

32. Give the position and the connexions with parts around of the urinary bladder in the male pelvis. Describe also its ligaments and the relations to it, of arteries, veins, and excretory tubes.

The male bladder is placed in the anterior part of the pelvis. In front of it is the symphysis pubis, and, if distended, the lower part of the abdominal wall. Behind, the recto-vesical pouch of peritoneum, and often folds of small intestines, separating it from the rectum.

In relation with the lateral part of the bladder are the obliterated hypogastric artery and vas deferens, and passing to it in the posterior false ligament are the ureter and vesical vessels. The fundus or base rests on the middle piece of the rectum, the vesiculæ seminales, and vasa deferentia intervening.

The neck is surrounded by the prostate gland. The bladder is retained in position by ligaments. These are divided into true and false.

The true ligaments are four in number, and are formed by processes of the recto-vesical fascia. Of these two anterior extend from the back of the pubes above the prostate gland to the front of the bladder. The lateral two ligaments are the portions of the rectovesical fascia which are reflected from the side of the pelvis on to the side of the prostate gland and bladder.

The false ligaments are five in number, and are formed by reduplications of the peritoneum; of these the two lateral extend from the iliac fossæ to the sides of the bladder, the two posterior from the posterior and lateral part of the bladder to the sides of the rectum, being raised by the vesical arteries to form a pouch of peritoneum. The superior false ligament extends from the summit of the bladder to the umbilicus and contains the urachus, a fibrous vestige of the duct of the allantois, with the sac of which the bladder communicates in fœtal life.

33. Describe the various means by which the urinary organs are maintained in their position, and all the differences which exist between them in a male child and an adult.

Beside the ligaments mentioned in A. 32, the bladder is retained in position by some areolar connexions between it and the rectum or vagina, according to sex.

In the child the bladder is pyriform, and is situated higher up in the pelvis than in the adult, extending into the hypogastric region; also the cervix instead of the fundus is situated the lower in the pelvis.

34. Describe the coverings and relations of the bladder in the distended state.

The bladder when distended rises out of the pelvis, so that its anterior part comes into relation with the lower part of the abdominal wall. The back and sides are covered with peritoneum, and the organ is surrounded by folds of the small intestine.

35. The prostate, its connexions with contiguous parts, and its structure.

The prostate encircles the neck of the bladder. In front of it is the triangular ligament of the urethra, behind it the bladder, below the last part of the rectum. Upon it are reflected the anterior and lateral true ligaments of the bladder. In structure it consists of a stroma of mingled unstriped muscular fibre and connective tissue, enclosing a glandular structure of small follicles communicating with tubular ducts, which unite to form the larger excretory ducts, the orifices of which are seen in the prostatic fossæ of the urethra.

36. Mention the length of each portion of the male urethra, and the position and appearance of the different objects inside each portion. De-

scribe the connexions of the permanent curve of the urethra.

The male urethra is divided into three portions, named prostatic, membranous, and spongy. The *prostatic portion* of the urethra is from an inch to an inch and a quarter in length, and is imbedded in the prostate gland. In the floor of this portion, is a narrow ridge, called the caput gallinaginis; on either side of this is a groove, the prostatic sinus, into which open the numerous ducts of the prostate gland. At the fore part of this crest is a recess, the sinus pocularis, upon the margins of which are the openings of the seminal ducts.

The *membranous portion* measures about three-quarters of an inch along its anterior or concave surface, but on account of the projection backwards of the bulb, only half an inch along its posterior surface. It is placed about an inch below the pubic arch, and behind is separated by an interval from the termination of the rectum. Immediately below it are Cowper's glands, and surrounding it are the fibres of the constrictor urethræ and deep transversus perinei muscles. It is the weakest portion of the urethra, but is strengthened by its piercing first the deep, and then the superficial layer of the triangular ligament.

The *spongy portion* of the urethra is much the longest, and comprises the rest of the canal, being about six inches in length. At its commencement, at the bulb of the corpus spongiosum it is somewhat dilated, and receives the ducts of Cowper's glands. It is of uniform size as far as the glans, and shows the openings of the urethral follicles. At the glans the canal is again dilated to form the fossa navicularis, opening into the roof of which is a larger recess, the lacuna magna. The meatus is the narrowest part of the tube.

37. Where are the testicles situated in early fœtal life? Describe by what agencies they are conveyed into the scrotum, what are their coverings in the belly and in the scrotum, and whence are these coverings derived. Where do the arteries of the testicles arise, and where do their veins terminate?

The testicle in early fœtal life is situated in the abdomen below the kidney, and covered in front only with peritoneum. It is guided into the scrotum by means of the gubernaculum testis. This consists of two parts, of which one, the gubernacular cord, passes from the cellular tissue of the peritoneal pouch, which precedes the testicle, into the scrotum; the other, or plica gubernatrix, extends from the testicle into the posterior part of the pouch of peritoneum. It is not, however, certain that the descent is effected by means of these structures. In the scrotum the testicle is covered by the skin, dartos, intercolumnar fibres derived from the external oblique tendon, cremasteric fascia from the internal oblique and transverse muscles, transversalis fascia, parietal and visceral layers of the tunica vaginalis derived from the peritoneum, and its own proper coat, the tunica albuginea.

The arteries of the testicle (spermatic) arise from the front of the abdominal aorta, a little below the renal arteries. Their veins terminate, the right in the inferior vena cava, and the left in the left renal vein.

38. Describe the course of the vas deferens, from the commencement to its termination, including its connexions with adjacent parts.

The vas deferens commences at the lower end of the epididymis, and ascends along the back of the testicle on the inner side of the epididymis, and behind the spermatic vessels to the external abdominal ring; it next passes outwards and upwards with the cord through the inguinal canal to the internal abdominal ring; then leaving the spermatic vessels it arches over the external iliac vessels downwards, backwards, and inwards, into the pelvis beneath the peritoneum, to reach the side of the bladder. It now curves downwards over the obliterated hypogastric artery, and between the bladder and the ureter to reach the base of the bladder between it and the rectum, and then running internal to the vesicula seminalis, joins with the duct of the latter to form the common seminal duct.

39. The uterus: describe its position, its ligaments; also the division of its cavity and the openings into it. (The ovaries and the Fallopian tubes need not be included.)

The uterus is situated in the cavity of the pelvis, between the bladder in front and the rectum behind.

The ligaments of the uterus are divided into true and false:—

The true ligaments of the uterus are the round ligaments. These are a pair of fibrous cords passing from the upper angles of the uterus to the internal abdominal rings, and thence through the inguinal canals to be lost amongst the cellular tissue of the mons veneris.

The false ligaments are formed by reduplications of the peritoneum. They are six in number, two anterior, two lateral, and two posterior.

The anterior ligaments are reflections of the peritoneum extending from the uterus to the bladder.

The lateral or broad ligaments extend from the lateral aspect of the uterus to the side of the pelvis. Within its fold are contained, from before backwards, the round ligament, the Fallopian tube highest, and the ovary, each being contained in a separate subdivision of the upper edge of the ligament.

The posterior ligaments extend from the back of the uterus to the rectum.

The cavity of the uterus is divided into that of the body and neck.

That of the body is triangular, with its base at the fundus, and having its corners prolonged towards the openings of the Fallopian tubes, whilst its apex extends downwards towards the cervix.

That of the neck is a narrow tube connected above by a constriction, the internal os, with the apex of the upper cavity and opening below into the vagina by a second constriction, the external os. It is, therefore, fusiform in shape narrowed at both ends. Along both its anterior and posterior surfaces the mucous membrane is arranged in the form of a median ridge, which is joined on each side by small ridges running obliquely downwards and inwards. This peculiar arrangement has received the name of the arbor vitæ.

40. Give a description of the topographical anatomy of the ovary, and of the structure of that viscus at the full child-bearing period—say 25 years of age. (The composition of the ovum and the changes in the ovary subsequent to the extrusion of the ovum are not wanted.)

The ovaries are two flattened elongated bodies, nearly an inch and a half in length, contained in the posterior fold of the broad ligament of the uterus; each is connected to the uterus by a fibrous band, the ligament of the ovary; above it, in the middle fold of the broad ligament, is the Fallopian tube, one of the fimbriæ of which is connected with the outer extremity of the ovary. In front of it, in the anterior fold of the broad ligament, is the round ligament of the uterus.

The ovarian vessels and nerves enter a deep groove or hilus in the anterior border.

Structure.—The ovary consists of a proper fibrous covering, the tunica albuginea, enclosing a reddish-white stroma, the fibres of which radiate from the hilus, through its substance to the tunica albuginea. Within the stroma, are a number of small sacs, the Graafian follicles, containing the ova, most numerous in the cortical portion.

41. Into what regions is the abdomen divided? State the boundaries of each region and the structures which are situated within it.

The abdomen is divided into regions, by lines drawn horizontally round it, one opposite the ninth costal cartilage, and the other opposite the crista ilii, which cut at right angles two vertical lines drawn one on each side, through the cartilage of the eighth rib, and the middle of Poupart's ligament. By these lines the abdomen is divided into nine regions, called on each side, from above down, hypochondriac, lumbar and iliac, and between these in the middle, epigastric, umbilical, and hypogastric.

The structures contained in these regions are as below.

Right Hypochondriac.	Epigastric.	Left Hypochondriac.
Right lobe of liver. Gall bladder. Hepatic flexure of colon. Commencement of duodenum. Upper part of right kidney. Right suprarenal capsule.	Pyloric half of stomach. Left lobe of liver. Lobulus Spigelii. Pancreas. Semilunar ganglion.	Fundus of stomach. Part of left lobe of of liver. Splenic flexure of colon. Spleen. Tail of pancreas. Upper part of left kidney. Left suprarenal capsule.

Right Lumbar.	Umbilical.	Left Lumbar.
Ascending colon. Right kidney. Second part of duodenum. Coils of jejunum.	Omentum. Transverse colon. Mesentery. Third piece of duodenum. Coils of jejunum and ileum.	Descending colon. Left kidney. Coils of jejunum.

Right Iliac.	Hypogastric.	Left Iliac.
Cæcum with ileocæcal valve and vermiform process. Right ureter.	Coils of ileum. Bladder (in children, and when distended). Uterus (when gravid).	Sigmoid flexure of colon. Left ureter.

CHAPTER VII.

DISSECTIONS.

QUESTIONS on dissections are the best test of practical knowledge of anatomy, for no amount of reading, unless combined with careful dissection, can enable the student to answer them.

In describing the various stages of a 'dissection,' the structures should be mentioned in the order in which they are to be found, and the more important points of their relative position may be noticed, but a minute anatomical description of each is not required unless specially stated.

In answering questions upon dissections it is well to proceed as follows:—

1st. Describe the position in which the subject should be placed preparatory to making the incisions.

2nd. Describe the incisions necessary, mentioning the direction in which the skin flaps should be reflected.

3rd. Mention the superficial vessels and nerves, lymphatic glands, &c., found in the superficial fascia, and their position.

4th. Describe the method of reflecting the deep fascia.

5th. Mention in relative position the structures seen on removing it.

6th. Mention what muscles, &c., it would be necessary to remove or turn aside, and how this is done, describing in order the structures exposed by such proceedings until the dissection is completed.

1. Describe the dissection of the part of the face within the following bounds:—Above, the upper edge of the zygoma and the fissure between the eyelids; below, the base of the lower jaw; in front, the middle line of the body; and behind, the posterior border of the ascending ramus of the jaw. (The dissection is to be carried downwards to the bone and the underlying cavities.)

Let the subject lie on the back with the face turned to one side.

The incisions required are, a semicircular cut about one inch below the fissure of the eyelids, a second along the ascending ramus, and lastly one along the lower border of the inferior maxilla. The flaps should be reflected upwards to the fissure of the lids and inwards to the middle line. Immediately below the fissure of the lids will be seen the orbicularis palpebrarum, a thin flat muscle. In front of the ear is the parotid gland, on the anterior border of which is a small process, the socia parotidis. Issuing from the anterior border of the gland are the transverse facial artery, parotid duct, and the facial nerve, the duct lying between the artery above and some branches of the nerve below. At the lower part will be seen the platysma. The facial nerve and transverse facial artery may be traced backwards through the substance of the parotid gland.

These structures having been removed, most of the muscles of the nose and mouth will be laid bare. Around the mouth is its sphincter, the orbicularis oris, and converging to be inserted into its borders are: the levator labii superioris alæque nasi from the internal angle of the orbit, its internal portion being inserted into the ala of the nose; the levator labii superioris from the lower margin of the orbit; the levator anguli oris from the canine fossa to the angle of the orbicularis. The zygomatici minor and major from the zygomatic process of the malar bone, the minor being anterior; the risorius Santorini from the fascia over the masseter; the depressor anguli oris from the oblique line of the lower jaw; and the depressor labii inferioris from the front of the lower jaw, overlapped by the former muscle at its outer border, and blending with the fellow of the opposite side at its inner. On the nose will be seen, extending as a downward process from the occipito-frontalis, the pyramidalis nasi, which blends below with the upper border of the compressor naris, a muscle which spreads out from the canine fossa across the nose. Below this, on the ala of the nose, are two small muscular slips, the dilatator naris, and passing down from the ala to be inserted into the orbicularis oris along with the labial portion of the levator labii superioris alæque nasi is a small slip, the depressor alæ nasi. Behind, extending from the zygoma to the angle of the jaw is the masseter. Running over the border of the lower jaw, just in front of the insertion of the masseter, to the angle of the mouth, and from thence to the side of the nose are the facial vessels, giving their labial and coronary branches, and terminating by dividing into the angular and lateral nasal branches. Issuing from the mental foramen of the lower jaw are seen the mental branches of the inferior dental artery and nerve. On removing these structures the ascending ramus of the lower jaw will be laid bare. In front of this is a mass of fat, and on cleaning it away, the buccinator muscle will be laid bare. Issuing from the infra-orbital foramen are to be seen the infra-orbital nerve, with some small vascular companions: this descends and forms a plexus with the facial nerve on the surface of the levator anguli oris. On the nose the lateral cartilages and the bones become exposed. On the deep surface of the orbicularis oris will be found some accessory slips to that muscle, a single pair below and an outer and inner pair above, running from the maxillary bones to blend with the rest of the muscles. Extending downwards from the alveolar process of the inferior maxilla to the lower lip is the levator menti. The removal of these structures would bring into view the mucous membrane of the mouth, and so complete the dissection.

2. Describe the dissection and the course and relations of the external maxillary (facial) artery and vein below the inferior maxilla. What branches arise from that portion of the artery, and to what parts are they distributed?

Place the subject on the back with a block under the neck so as to throw back the head; turning the face on to the opposite side. Incisions: those of anterior triangle along the lower border of the ramus of jaw and along sternomastoid, reflect forwards to the middle line. This will bring into view branches of superficial cervical nerve of the cervical plexus and the platysma, a thin subcutaneous muscle passing upwards and forwards on to the face. On reflecting the platysma upwards on to the face, will be seen the infra-maxillary branches of facial nerve. In front is the anterior belly of the digastric, next the submaxillary gland, further back still the stylohyoid and posterior belly of digastric.

Reflect the stylohyoid and posterior belly of the digastric.

By these steps the whole course of the facial artery below the jaw will be laid bare.

Tabulate the branches of the artery, giving opposite each the part to which it is distributed.

3. What is the dissection required to expose the whole course of the occipital artery? Describe its origin, course, relations, branches, ultimate distribution and anastomoses, and give the communications and termination of its vein.

The dissection of occipital artery is conducted in three stages—

1st. At its origin.

2nd. Beneath the sternomastoid.

3rd. On the scalp.

1st stage: subject to be placed on the back with face turned to the opposite side to the dissection.

Incisions: those of the anterior triangle along sternomastoid, and along lower margin of jaw; reflect forwards, clean platysma and reflect it upwards on to the face.

Clean the external carotid artery and the origin of its branches and the ninth nerve; this will expose the first part of the artery.

2nd stage: Body lying on the face.

Incision along the superior curved line of occipital bone; an incision has already been made along the sterno-mastoid. Reflect the skin to the middle line.

In order to expose the artery, which here lies very deeply, it will be necessary to remove successively the sterno-mastoid and trapezius, and next the splenius, trachelo-mastoid, and posterior belly of the digastric. The artery will be found first in a groove on the inner side of the mastoid process, and then piercing the trapezius.

3rd stage. Body on the face.

Incision along middle line of scalp. Reflect forwards from superior curved line. The termination of the artery branching and ramifying will thus be laid bare.

For description of the vessel, see systematic works. Most important communications of vein, by mastoid foramen with lateral sinus; at various points with the veins of the diploe. Termination in external jugular.

4. The skull being opened and the brain removed in the usual manner, describe the dissection necessary to demonstrate the parts which lie in the middle fossa of the cranial cavity.

Subject to be placed on its back with the head raised on a block.

Dissect off outer layer of dura mater from the outer wall of cavernous sinus.

This will lay bare in order, from above downwards, the third and fourth nerves and the superior division of the fifth. In front this order will be found to have altered, the fourth having become highest, while the ophthalmic and third nerves have each divided. Of the ophthalmic two branches, frontal and lachrymal, pass through the sphenoidal fissure at a level a little below the fourth; while the nasal issues lower, between the two divisions of the third. The third and fourth nerves may be traced back to the points where they pierce the dura mater, close to the anterior clinoid process, and just outside this on the free border of the tentorium; the ophthalmic may be traced to the Gasserian ganglion. From the Gasserian the second and third divisions of the fifth nerve extend to the foramina rotundum and ovale respectively.

Next, open the cavernous sinus, and show in its inner wall the internal carotid artery with the sixth nerve lying on its outer side.

Two plexuses of the sympathetic may be seen on the artery, the carotid plexus on the outside, and the cavernous plexus in the inner. If the part has been properly hardened in spirit, communications may be shown between the former and the sixth nerve and Gasserian ganglion, and between the latter and the third, the fourth, ophthalmic, and lenticular ganglion.

Make an incision along the superior border of the petrous bone, and carefully tear the dura mater forwards from the bone, till the whole middle fossa is denuded. By this process the following structures will be laid bare:—The great superficial petrosal nerve issuing from the hiatus Fallopii, and passing beneath the Gasserian ganglion to penetrate the cartilage which fills the middle lacerated foramen, and receiving a branch from the carotid plexus as it passes the artery; external to this, a smaller nerve, the external superficial petrosal, which, after receiving a communication from the sympathetic on the middle meningeal, leaves the fossa through the foramen ovale or near it; the middle meningeal artery, entering through the foramen spinosum, and passing forwards and upwards, anastomosing with the lachrymal through the sphenoidal fissure, and, by a branch through the hiatus Fallopii, with the numerous arterial twigs distributed to the organ of hearing; the small meningeal, entering through the foramen ovale; a small twig from the ascending pharyngeal, entering through the middle lacerated foramen.

5. What dissection would you make to obtain a satisfactory view of the lachrymal gland? Describe the position and arrangement of the whole apparatus concerned with the removal of the tears from the front of the eyeball.

Subject to be laid on its back, with head supported by a block.

Remove the skull-cap and brain.

Make vertical incisions through the frontal bone at the internal and external angular processes. From these incisions, chisel through the roof of the orbit, so that the posterior ends of the incisions meet at the anterior clinoid process. Turn forwards the piece of the frontal thus freed, and remove with the bone nippers any remaining part of the roof of the orbit.

Remove the periosteum of the orbit.

The gland will now be seen lying at the anterior and outer part of the cavity in a hollow behind the external angular process, and it should be cleaned from the surrounding fat.

In replying to the latter part of the question a description would be required of the shape, structure, &c., of the gland; the number and position of its ducts; the puncta, canaliculi, lachrymal sac and nasal duct (see Chap. VI. Q. 9).

6. Of what structure is the pinna of the ear composed, and what are its attachments to the head? Describe the various marks which distinguish its surfaces and give the origins and insertion of its muscles. What arteries and nerves are supplied to it; from what main vessels are the first-named derived; and from what parts of the cerebro-spinal axis do the nerves have their superficial origin?

The pinna of the ear is composed of a reduplication of the integument, supported by a scroll-like plate of elastic cartilage. This is curled over at the edge to form the helix, the groove formed by this is named the fossa of the helix; next to this is an eminence, the antihelix, which is succeeded at its upper part by a depression, the fossa of the antihelix. The hollow in the centre is called the concha. In front is the rounded projection of the tragus, on the opposite side the antitragus; the skin, unsupported by cartilage, but containing loose fat, is projected below as a rounded prominence, the lobule; attached to the cartilage are the several *intrinsic* muscles. These are six in number, and are very small and pale. On the anterior part of the helix are two slips, the small and large muscles of the helix. The larger is situated above the smaller, they follow the curve of the helix.

On the tragus are a few fibres called the tragicus, and on the eminence of the antitragus the antitragicus. On the posterior surface of the pinna are two small muscles. Of these, the 'transverse' muscle extends from the projection corresponding to the form of the antihelix to that of the concha, while the 'oblique' muscle passes from the concha to the back of the helix.

The pinna is attached to the head by three extrinsic muscles: the attrahens, attollens, and retrahens aurem. It is also firmly fixed by cartilage to the margins of the meatus auditorius externus, and by some ligamentous bands to the temporal bone.

Arteries, from posterior superficial temporal, auricular, and occipital.

Nerves, from posterior auricular of facial—origin, upper part of medulla oblongata; auricular of pneumogastric—origin, groove between olivary and restiform bodies; auriculo-temporal of inferior maxillary of fifth—origin, side of pons near its upper edge.

7. Name the tissues which form the scalp and the blood-vessels and nerves which supply it.

The tissues forming the scalp are as follow:—

First, the skin containing the hair bulbs with the sebaceous glands.

Next, a layer of yellow granular fat containing cutaneous vessels and nerves.

Next, the occipito-frontalis, consisting of, in front, a thin muscular expansion, behind two muscular planes placed laterally, united by an intervening aponeurosis, the anterior and posterior portions being joined by a wide tendinous aponeurosis.

Next, some loose cellular tissue.

Lastly, the fibrous pericranium.

Arteries: supra-orbital, frontal, superficial temporal, dividing into anterior and posterior branches, occipital, and posterior auricular, dividing into mastoid and auricular branches.

Veins similar to the arteries.

Nerves, supra-orbital, supra-trochlear, temporal branches from auriculo-temporal, temporo-malar and facial, posterior auricular, auricular of pneumogastric, great auricular, greater and lesser occipital.

8. Name in the order, in which they are placed, the parts in the space corresponding to the outline of the masseter muscle, beginning immediately under the skin and ending at the pharynx.

Immediately under the skin is a thin layer of superficial fascia, containing twigs of the malar branch of the temporo-malar nerve.

Next, the anterior border of the parotid, with its companion gland and duct, above which the transverse facial artery crosses the masseter, and below it the facial nerve in several parts.

Next, the masseter muscle, covered by a thin fascia and divisible into a superficial and a deep portion.

Next, the ascending ramus of the inferior maxillary bone, with its condyloid and coronoid processes, to the former of which is attached the capsular ligament of the temporo-maxillary articulation and the external pterygoid muscle; while into the latter is inserted the temporal muscle. Issuing through the sigmoid notch are seen the masseteric artery and nerve.

Next, the internal maxillary artery, lying on the external pterygoid muscle, and giving upwards its middle and small meningeal, tympanic, and deep auricular branches, and downwards the inferior dental, besides branches to the pterygoid, temporal, and buccinator muscles.

Next, the external pterygoid muscle, extending transversely outwards and backwards from the external pterygoid plate to the condyloid process of the inferior maxilla. Next appears the trunk of the inferior maxillary nerve, dividing into its anterior and posterior divisions, the anterior, mainly motor, giving branches to the pterygoid muscles, the masseter, the temporal, and the buccinator; the posterior, larger and mainly sensory, giving a branch to the internal pterygoid muscle, the auriculo-temporal backwards, and the gustatory and inferior dental downwards. Close to the base of the skull, the gustatory is joined by the chorda tympani, a branch of the facial. Connected with the nerve to the internal pterygoid muscle is the otic ganglion. Between the two pterygoid muscles also is the pterygoid plexus of veins.

Next the Eustachian tube, giving origin to the tensor palati muscle, and lastly, the superior constrictor of the pharynx and the buccinator.

9. Supposing an incision drawn from the middle of the forehead over the pinna of the ear to the middle of the occiput above the superior curved line of the occipital bone, name in order, from before backwards, the several structures divided upon the surface to the bone (including the arteries and nerves).

The incision in the first place would, throughout its whole course, divide the skin and subcutaneous cellular tissue.

Next it would divide the anterior portion of the occipito-frontalis, the attollens aurem, two layers of temporal fascia, and the temporal muscle, the posterior portion of the occipito-frontalis, and the occipito-frontal aponeurosis. Lastly, the pericranium.

The arteries and nerves divided are as follows:—The frontal artery and the supra-trochlear nerve; the supra-orbital artery and nerve; temporal branches of the facial and temporo-malar nerves, the anterior branch of the temporal artery, the anterior branch of the temporal division of the auriculo-temporal nerve, the posterior branch of the temporal artery, the posterior branch of auriculo-temporal nerve; the middle temporal artery; the deep temporal artery and nerves; the great auricular nerve; the posterior auricular artery, and the auricular branch of the pneumogastric; the lesser occipital nerve; and the occipital artery and greater occipital nerve.

10. Describe the dissection necessary to expose in an entire subject the course and branches of the internal mammary artery in its whole length.

Place the subject on the back.

Incisions: one along clavicle, a second along the middle line of the body, nearly as far as the umbilicus, and lastly, one outwards at right angles to the second at its termination. Reflect outwards. Notice the small perforating branches of the artery.

Detach the pectoralis major from its origin.

Disarticulate the clavicles, cut through the cartilages of the ribs close to the sternum, make a second line of cuts through the ribs, about two inches outside the first, and remove the piece of thoracic wall, thus marked out, from the subjacent pleura, taking care not to injure the artery or its anterior intercostal branches. Clean the artery and its intercostal and mediastinal branches, following it up to its origin from the subclavian, and downwards to opposite the sixth space, where it bifurcates into superior epigastric and musculo-phrenic.

To follow the former, open the sheath of the rectus, turn the muscle aside, and trace the branch till it becomes lost in the muscle.

The latter may be traced outwards to the eighth rib, where it pierces the diaphragm; to follow it, it would be necessary to reflect the upper part of the abdominal wall, by making deeper the skin cuts, and to trace it along the under surface of the diaphragm as far as the last intercostal space.

Soon after the internal mammary artery enters the chest it gives off a small companion branch to the phrenic nerve. The branch may be traced along the phrenic nerve by cleaning the pleura from it as it runs along the pericardium.

11. The anterior wall of the thorax having been removed, state—(*a*) how you would expose the front and sides of the pericardium; (*b*) the incisions required to open it; (*c*) the appearance presented by the heart *in situ*; (*d*) the incisions you would make through the walls of the auricles and ventricles to obtain a complete view of the cavities of the heart, and the position and arrangement of the valves in connexion with it.

Place the subject on the back. Clean the loose cellular tissue from the front of the pericardium. Open the pleural cavity, turn aside the lungs, and clean the fat and pleura from the sides of the pericardium, and front of root of the lungs on each side. Lift each lung from the pleural cavity, and bring it forwards and across the chest, so as to be able to reach and remove the pleura from the posterior portion of the sides of the pericardium and root of the lungs.

To open the bag, make one incision along its base, *i.e.* where it is applied to the diaphragm, and a second cut from the middle of the first to the apex of the pericardium, the exit of the great arteries.

The heart, as seen *in situ*, presents a somewhat conical form, with the apex of the cone forwards and to the right, and the base backwards and to the left, its axis being nearly horizontal; near its upper border is seen a line, the interventricular sulcus, about which there is generally more or less fat; close to its extremity it will be seen to be crossed at right angles by a second line, the auriculo-ventricular sulcus.

The whole of the fleshy mass below the horizontal line consists of the right ventricle, which thus forms the greater part of the front of the heart, its apex and upper border being all that is contributed by the left.

The right ventricle at its base prolongs itself upwards as an infundibulum, to give origin to the pulmonary artery, which is overlapped by a dog's-ear-like structure, the right auricular appendage. Behind the pulmonary artery, passing upwards and to the right, may be seen the commencement of the aorta. Coming to the front, one on each side of the pulmonary artery, are the two coronary arteries, the right of which passes backwards along the auriculo-ventricular sulcus, while a branch of the left may be seen taking its course along the anterior inter-ventricular groove.

In order to examine the valves and cavities of the heart, the following incisions are necessary :—

Right auricle. One along its free border from the superior nearly to the inferior vena cava, and a second from the centre of the first to the tip of the auricular appendage.

Right ventricle. Transfix from before backwards near the septum and cut downwards, bringing out the knife near the apex ; prolong the anterior limb of the V, thus made, upwards through the infundibulum and pulmonary artery.

Left auricle. One incision joining the right and left pulmonary veins, and a second downwards, at right angles from the middle of the first.

Left ventricle. Transfix at base near septum, and bring out the knife near the apex; produce the anterior cut so as to slit up the aorta.

12. Name the serous membranes connected with the diaphragm, and the viscera in contact with it, stating the position of each of the several viscera with reference to the diaphragm.

The serous membranes in contact with the diaphragm are the two pleuræ, and the pericardium above, and the peritoneum below.

By its thoracic surface the diaphragm is in contact with the lungs on each side. The right lung reaches as far forward as one inch and a half from the middle line, while the left does not come within three and a half inches of that line, though, on account of the triangular form of the base of the pericardial bag, it reaches more to the right posteriorly. The space between the lungs is occupied by the heart enclosed in the pericardium.

By its abdominal aspect the diaphragm is in contact, on the right side, with the liver in front, and the corresponding kidney and adrenal behind, the liver extending across the middle line into the left half of the abdominal cavity. On the left side the diaphragm is in contact in front with the stomach, and behind that viscus, with the spleen, and left kidney, and adrenal, the crura of the diaphragm arch over the aorta, extending on either side of it, down the front of the spinal column. In front of the right crus is the vena cava. Less intimately related are the pancreas, the third part of the duodenum, the cœliac axis, and the semilunar ganglia.

13. Supposing the left hip-bone of the male pelvis removed, without the internal obturator muscle, what steps should be taken to show the muscles and ligaments closing the outlet of the pelvis?

The parts closing the outlet of the pelvis are, from behind forwards:—First, the pyriformis, passing through the great sciatic notch, with the gluteal vessels and nerve above it. Next, extending from the spine of the ischium to the side of the coccyx, are the coccygeus and lesser sacro-sciatic ligaments, the sciatic vessels and nerves issuing from the pelvis between them and the pyriformis. Next comes the levator ani, which closes the rest of the space, with the exception of a small interval in front containing the prostate gland and urethra, which is closed only by the recto-vesical fascia, an areolar plane lining the upper surface of the levator ani, and giving processes to the rectum, bladder and prostate.

In order to demonstrate these structures, clean out the fat from between the obturator internus, and lower surface of levator ani, and coccygeus; define those muscles, and clean the lesser sacro-sciatic ligament. Next, by detaching the fibres of the levator ani at their origin, and throwing it and the coccygeus downwards, the recto-vesical fascia will be exposed. Next, the sheaths which it sends on to the rectum and prostate may be demonstrated. Lastly, the pelvic aspect of the pyriformis and the sacral plexus may be defined.

14. How would you dissect the male peri-

næum, commencing with the reflection of the skin, so as to show the triangular ligament? Give the relations of the structures met with so far as they are exposed in the course of dissection. Describe the vessels and nerves laid bare.

Subject to be placed on its back, with the thighs flexed on the trunk and the knees on the thighs; a block is to be placed beneath the pelvis, which should be drawn to the edge of the table.

Incisions: Three transverse cuts, each extending about three inches on either side of the middle line; the first immediately behind the scrotum, the second in front of the anus, and the last at the tip of the coccyx.

These are to be connected by an incision along the middle line and round the anus.

Reflect the two posterior flaps. Immediately beneath the skin will be found the sphincter ani, the orbicular muscle closing the anus, extending from the tip of the coccyx behind to the central point of the perinæum in front. After this muscle has been dissected, on one side remove the fat from the ischio-rectal fossa, so as to expose the levator ani and obturator muscle with its fascia; on the other side, clean the hæmorrhoidal and superficial perineal vessels and nerves, tracing them back to the internal pudic trunks—of which a systematic description should be given, including their branches. A small twig of the fourth sacral nerve will be found piercing the fibres of the levator ani behind.

Reflect the anterior flaps. Remove the fat, or superficial layer of the superficial fascia, noticing the long pudendal nerve crossing the ramus of the pubes and then piercing the deep layer of the superficial fascia; clean the deep layer of the superficial fascia, noticing its attachment to the arch of the pubes, its median septum, and the process which it sends backwards, behind the superficial transverse perineal muscle, to join the posterior border of the triangular ligament; and reflect it by incisions similar to those in the skin.

After the removal of the deep layer of the superficial fascia a triangle of muscles will come into view. Extending on either side from the anterior part of the ischial tuberosity, to be inserted into the crus penis, is the erector penis forming the outer side of the triangle. The base is formed by the transversus perinæi muscles, which arise from just in front of the tuberosity of the ischium, and are inserted into the central point of the perinæum.

In the middle line, dividing this triangle into two smaller ones, is the accelerator urinæ. This muscle, taking origin behind from the central point of the perinæum, and in front of this from a median raphe, is divided into three parts; the posterior fibres are seen to pass outwards to be inserted into the triangular ligament; the middle encompass the urethra and join with the muscle of the opposite side on the other side of the urethra; while the most anterior fibres are inserted into the outer aspect of the crus penis, in front of the erector penis.

In the triangle thus formed are the superficial perineal artery and two superficial perineal nerves extending forwards; the transverse perineal artery crossing the posterior part of the space, and the long pudendal nerve going with the superficial perineal.

By removing the above muscles, &c., the bulb and the commencement of the spongy portion of the urethra in the middle line, and the crus penis, a strong fibrous tube of erectile tissue, along the arch of the pubes, will be exposed.

By removing these structures the anterior layer of the triangular ligament will be completely exposed. This, about an inch and a half in depth, is attached at its apex to the symphysis, and along its sides to the arch of the pubes, while behind it is only connected with the central point of the perinæum, and the thin fascia covering the under surface of the levator ani.

On removing this anterior layer, which is very thin, the structures contained between the two layers of the triangular ligament will come into view. Crossing the base of the space from the pubic arch, to join with the muscle of the opposite side, is the deep transverse perineal muscle. Arising from the pubic arch above this is the constrictor urethræ which also crosses the space, splitting to enclose the membranous portion of the urethra, which perforates the ligament about an inch below the symphysis pubis. On removing the deep transverse muscle, Cowper's glands, two small bodies about the size of a pea, will be exposed, lying just below the urethra. Ascending along the arch of the pubes will be found the continuation of the internal pudic vessels and nerve. They give the following branches: running nearly transversely inwards near the base of the triangle are the artery and nerve of the bulb. Entering the corpus cavernosum is the artery of that structure; and running forwards with the continuation of the internal pudic nerve, to pass between the crura penis and the bone, is the dorsal artery of the penis. Besides these there are muscular branches. The single dorsal vein of the penis pierces the ligament a little above the urethra. The removal of these structures will lay bare the posterior layer of the triangular ligament, which, though united at its lower border with the anterior layer, will be seen to be attached to the arch of the pubes a little behind it above, so as to leave the space which contains the above-mentioned structures.

15. Supposing the abdomen open, but the contents undisturbed, state what pieces of the peritoneum would have to be cut through and what removed in laying bare the pancreas; what dissection should be made to show the ending of the pancreatic duct, without removing the viscus from the abdomen?

Cut through the gastro-colic omentum close to the stomach, and then remove the ascending layer of the meso-colon.

To show the ending of the duct, separate the head of the pancreas from the second portion of the duodenum, with the fingers. Between the two behind will be found the duct, either joined by the bile duct or piercing the wall of the second portion of the duodenum close to it.

16. How would you expose and demonstrate,

in a subject with the bowels already removed, the lumbar plexus of nerves?

Cut through, and turn aside the external iliac vessels, and take away piece meal the psoas muscle, taking care not to injure the genito-crural nerve lying on its surface, or the accessory obturator along its inner border.

17. Describe the steps of the dissection required to demonstrate, in a subject in which the abdominal cavity is already opened, the whole course of the duodenum.

Place one double ligature at the sigmoid flexure of the colon, and a second at the point where the duodenum terminates in the jejunum, opposite the left side of the second lumbar vertebra, and remove the intestines included between the ligatures by cutting the layers of peritoneum that connect them to the abdominal wall and to other viscera. Inflate moderately the duodenum and stomach, and remove from them the loose fat and peritoneum.

18. The cavity of the abdomen having been opened, (*a*) describe the position and arrangement of the intestinal canal, as far as can be seen without dissection; (*b*) then state how you would expose the superior and inferior mesenteric arteries and their branches; (*c*) lastly, describe the mode in which you would remove the intestines, except the duodenum and rectum, from the cavity.

(*a*) On the left side is a portion of the stomach, from the lower border of which hangs the gastro-colic or great omentum, reaching as far as the pelvis. Through this semi-transparent structure are seen the transverse colon, crossing transversely below the stomach, and below this the small intestine. Raise up the small intestines, and gather them to the left, when, in the right iliac fossa, the cæcum will be visible with the right colon running upwards through the lumbar region to join the transverse colon. By gathering the intestines to the right the descending colon is seen in the left lumbar region terminating in the sigmoid flexure below.

(*b*) Draw up the transverse colon, with the great omentum, on to the ribs and secure them with hooks. Running between the two layers of the mesentery the branches of the superior mesenteric artery may be distinguished. Expose these by removing the anterior layer of the mesentery, and trace them in one direction to the parent trunk, and in the other to the intestine. Next turn the small intestine to the left side of the abdominal cavity, and trace out in a similar manner the branches which this vessel gives to the cæcum (ilio-colic), ascending colon (colica dextra), and transverse colon (colica media). Now turn the small intestines to the right side. In front of the aorta, about a couple of inches above its bifurcation, or immediately below the transverse duodenum, will be seen the inferior mesenteric artery. Expose it by removing the peritoneum from in front of it, and trace out its branches to the descending colon (colica sinistra), sigmoid flexure, and rectum (superior hæmorrhoidal).

(*c*) See above. Question 16.

19. The abdominal cavity having been opened and the bowels removed, give the dissection necessary to follow the left ureter from its origin to its termination.

Remove the peritoneum and loose fat from the front and inner side of the left kidney. Next clean and cut through the renal vessels, taking care not to injure the pelvis of the kidney, which lies immediately underneath them; having found this, follow the ureter downwards over the psoas muscle to the brim of the pelvis, by removing the peritoneum and loose fat from around it. At this point the ureter is in relation with the sigmoid flexure of the colon, which must be removed by cutting through the sigmoid meso-colon. Here it enters the posterior false ligament of the bladder, between the layers of which it must be followed to the base of the bladder. On separating the bladder from the subjacent rectum the ureter will be seen to be continued between them, until it terminates by obliquely piercing the coats of the bladder about one inch and a half behind the prostate gland.

20. Where is the inguinal canal? What parts form its boundaries? Describe its openings, the parts which are therein found, and the relations of these parts to each other in the male.

The inguinal canal is situated between the flat muscles of the abdomen, above Poupart's ligament. It extends from the internal abdominal ring, situate midway between symphysis pubis and iliac crest, to external abdominal ring, close to crest of pubes.

Openings.—Internal abdominal ring, an aperture in the transversalis fascia, oval in form, with the long diameter nearly vertical. Above and on its inner side is the transversalis muscle, below is Poupart's ligament.

External abdominal ring—an opening in the tendon of the external oblique muscle, somewhat triangular in form, having its base at the crest of the pubes, and its apex pointing upwards and outwards. The margins of this opening are called its inner and outer pillars; of these the inner is the weaker, and is straight, taking its origin from the symphysis and from the pubic bone of the opposite side, while the outer is bent round the cord so as to form the outer side and base of the triangle, and, being continuous with Poupart's ligament, is attached to the spine of the pubes.

Boundaries.—In front:—Skin, &c., aponeurosis of the external oblique muscle, throughout its whole length; internal oblique for outer third only of the canal. Behind:—Conjoined tendon (inner half); fascia transversalis, subperitoneal fat, and peritoneum throughout whole length. *Contents*:—Spermatic cord consisting of vas deferens, spermatic artery, and vein, and nerves, and lymphatics of testicle bound together by the remains of the tube of peritoneum, which in the fœtus connects the tunica vaginalis with the abdomen; the cord is covered by the infundibuliform fascia, a process of the transversalis fascia, the cremasteric muscle, with its nerve filaments, the genital branch of the genito-crural, and a twig from the epigastric artery (the artery of the cremaster), and by a few fibres the inter-columnar fascia derived from the tendon of the external oblique muscle.

21. Contrast the anatomy of an oblique and a direct inguinal hernia.

The internal aspect of the anterior part of the abdominal wall is divided into fossæ by certain fibrous bands, the remains of the urachus, in the middle line, and on either side the obliterated hypogastric arteries, so that there are, on both sides, two fossæ, one internal and the other external to the obliterated hypogastric, and, therefore, in the normal condition of the parts, to the deep epigastric artery which lies close in front of, and a little external to, it. The oblique hernia finds its point of exit in the external of these fossæ, while the direct issues from the internal. On account of the different arrangement of the constituents of the abdominal wall in the two fossæ, the coverings of a direct differ in character, but not in kind, from those of an oblique hernia. Thus, while both alike obtain similar coverings from the peritoneum, sub-peritoneal fat, and intercolumnar fascia, the covering of transversalis fascia obtained by the direct hernia is modified to form the infundibuliform fascia, in the case of the oblique; and while the direct hernia carries in front of it the conjoined tendon, the oblique, escaping the transversalis muscle, which arches over it, carries forward the cremasteric fascia from the internal oblique. Passing through the conjoined tendon, the direct hernia is to the inside of the epigastric artery, while the oblique, in its passage through the inguinal canal, is at first to the outside of that vessel and then passes in front of it.

22. **Describe the dissection of the internal circumflex iliac vessels; and point out how the anatomy of their trunks and branches could be shown by the dissection you make.**

Lay open the abdominal cavity by means of an

incision along the linea alba, crossed by transverse cuts opposite the anterior superior spine of the ilium and the cartilage of the ninth rib, and reflect the flaps thus made.

Clean the peritoneum and sub-peritoneal fat from the inner surface of the lowest flaps on each side, and from the external iliac artery.

Arising from the outer side of the termination of the external iliac artery, opposite the junction of the transversalis and iliac fascia, the deep circumflex iliac pierces these at their junction almost immediately after its origin.

Remove these fasciæ and the artery will be seen to run outwards, below Poupart's ligament, and along the crest of the hip bone to about its middle. Here it pierces the transversalis muscle, and if this be cut through, the artery may be followed between it and the internal oblique to its termination. Some branches may be traced to supply the abdominal wall, and, by removing the iliac fascia, and raising the iliacus muscle, branches may be traced to supply the iliacus and to anastomose with the ilio-lumbar and lumbar arteries.

23. What muscles should be divided in order to expose the posterior scapular artery, from its origin to its termination?

The posterior scapular artery takes its origin from the transverse cervical near the outer edge of the levator anguli scapulæ, and, passing backwards and downwards, terminates at the inferior angle of the scapula.

The muscles divided in order to lay it bare throughout this course would be—the trapezius, levator anguli scapulæ, rhomboideus major, and rhomboideus minor.

24. Mention in their order the parts which must be removed in exposing completely the supraspinatus muscle.

In order to expose the supraspinatus muscle it would be necessary to remove the skin over the supraspinous fossa, the part of the trapezius muscle inserting into the upper lip of the spine of the scapula, the acromion process of the scapula, the coraco-acromial ligament, and a strong fascia with fat that covers the muscle.

25. Name the boundaries of the axilla; also the vessels and nerves which it contains, and state their relative position.

In front. Skin, &c., pectoralis major and minor, and prolongation of costo-coracoid membrane to the sheath of the pectoralis minor.

Behind. Subscapularis, teres major, and latissimus dorsi muscles.

Internally. First four ribs, with their intercostal muscles, and the upper five serrations of the serratus magnus.

Externally. The bicipital groove of the humerus, covered by the biceps and coraco-brachialis.

Apex. A small triangular space between the clavicle, upper costa of scapula, and first rib.

Contents. Axillary artery, and vein lying on its outer side, with their branches; the brachial plexus of nerves, arranged in the first portion of the artery, as two cords, to the outer side; in the second portion as three cords lying, one outside, one inside, and a third behind: and in the third portion break-up into branches, of which the median and musculo-cutaneous are on the outer; the ulnar and lesser internal cutaneous on the inner; the inner head of the median and internal cutaneous superficial; and the musculo-spiral and circumflex behind. Crossing the space to the posterior part of the inner side of the arm are one or two intercosto-humeral twigs of nerve from the second and third intercostal trunks. Along the inner wall is the nerve of Bell, and on the posterior wall the three subscapular nerves, branches of the brachial plexus. The space also contains lymphatic glands and vessels and a quantity of loose fat.

26. Suppose a circular incision of the skin to be made round the arm, at the level of the point of insertion of the deltoid muscle, and a second incision to be made round the fore-arm one inch below the head of the radius; give the relations of the various structures met with in dissecting, between those lines, to the periosteum and to the ligaments of the joint.

On removing the skin will be seen the superficial fat, with cutaneous nerves and veins, the latter ending on the inner side in the median basilic and basilic; and on the outer side, in median cephalic and cephalic, which run respectively in inner and outer bicipital hollows. Close to the basilic vein, and passing underneath the median basilic are branches of the internal cutaneous nerve, and a little further back is the termination of the lesser internal cutaneous. On the outer side, near the cephalic vein, are the two external cutaneous branches of the musculo-spiral, and, lower, crossing the median cephalic vein, is the musculo-cutaneous. On removing, the fascia are seen in front the biceps muscle, and the process from its tendon inwards to the fascia of the arm; removing the biceps the brachialis anticus is brought into view. On its inner side above is the insertion of the coraco-brachialis, and below the origin of the pronator teres; on its outer side, below, the origin of the supinator longus, and extensor carpi radialis longior; crossing it outwards is the external cutaneous nerve, and near this, below, is the termination of the musculo-spiral nerve. On the inner side of the muscle is seen the median nerve, crossing the brachial artery, and internal to these are the internal cutaneous and ulnar nerves, with which latter runs the inferior profunda artery. On pressing aside the common origin of the flexor muscles from the internal condyle, the bifurcation of the brachial artery will be fully exposed, and the median nerve passing between the two heads of origin of the pronator teres. The supinator brevis is seen winding round the radius to be inserted into it. On removing these, the bones and ligaments will be entirely laid bare in front. On removing the fat from the hinder part of the limb the triceps muscle is exposed, and on dissecting away the triceps the musculo-spiral nerve and the superior profunda artery are seen winding outwards round the bone, as well as the branch which they send downwards to the anconeus. To the outer side is the common tendon of origin of the extensor muscles, and below the origin of supinator brevis. On removing these the bones and ligaments would be completely laid bare.

27. Describe the dissection necessary to lay open throughout its course the inferior profunda artery of the arm.

Place the limb on its back, with the scapula raised on a block. Make an incision along the middle line in front, from the axilla to two inches below the elbow, with transverse cuts at either extremity. Reflect the inner flap. Make similar incisions through the aponeurosis of the limb. Turn outwards the biceps, and define the brachial artery. Just opposite the insertion of the coraco-brachialis, it will be seen to give off a branch, the inferior profunda. The branch leaves the parent trunk and pierces the internal intermuscular septum; the latter must be cut through, and the vessel followed, in company with the ulnar nerve, to the interval between the olecranon and the internal condyle, where it terminates by anastomosing with the posterior ulnar recurrent, &c.

28. What parts must be removed in order to expose the entire of the flexor digitorum perforatus?

In order to expose the flexor digitorum perforatus it would be necessary to remove the skin of the front of the forearm, palm, and fingers; the subcutaneous cellular tissue, veins, and nerves of the same region; the palmaris brevis; the deep fascia of the forearm, the annular ligament, the palmar fascia, and digital sheaths; the pronator teres, flexor carpi radialis, and palmaris longus; and, in the palm, the superficial palmar arch, and median nerve.

29. **What are the dissections required to expose the course of the radial artery in the front of the fore-arm? Mention the superficial structures which are seen or removed in doing so.**

Place the limb flat on the table, with the palm uppermost.

Incisions.—One along the middle of the front of the forearm, from one inch below the elbow to the wrist, with transverse cuts at each extremity of the longitudinal incision. Reflect the outer flap; notice radial veins and external cutaneous nerve in the superficial tissues; take away the fat and fascia, and clean the supinator longus, which lies to the outer side of the vessel, and overlaps it, and the part of the pronator teres, and the flexor carpi radialis, which lie internal to the vessel. By separating the supinator longus from the pronator teres and flexor carpi radialis, the artery will be laid bare throughout its whole course in the forearm.

30. Give the dissection required to expose the posterior interosseous artery of the fore-arm in the whole of its course, mentioning, in the order in which they occur, the parts that must be removed in order to expose it.

Place the limb flat on the table, with the back of the arm uppermost.

Incisions.—One, longitudinal from elbow to wrist, with transverse cuts at each of its extremities. Reflect skin. In the superficial fascia trace the posterior branch of the external cutaneous nerve, the radial, the lower external cutaneous of musculo-spiral, and the posterior branch of the internal cutaneous nerve; the posterior ulnar, and a few small vein branches. Remove the fat and superficial structures, and dissect the superficial layer of muscles—viz. supinator radii longus, extensor carpi radialis longior, extensor carpi radialis brevior, extensor communis digitorum, extensor minimi digiti, and extensor carpi ulnaris—and remove them, taking care not to injure the termination of the artery, as it lies along the outer edge of the extensor carpi ulnaris. Clean the artery lying between the two layers of muscles, and trace it back to where it perforates between the contiguous borders of the supinator radii brevis and the extensor ossis metacarpi pollicis. Separate these muscles, and notice it coming through above the interosseous membrane, and arising from a larger artery, the common interosseous.

31. By what dissection would you expose the superficial palmar arch? Describe its mode of formation, its relations, and the distribution of its branches.

Place the limb with the palm uppermost.

Make an incision along the middle line of the palm from the wrist to the fingers, and transverse cuts at its extremities across the wrist and the web of the fingers.

Reflect the flaps.

Remove the subcutaneous fat, with the palmar cutaneous branches of the median and ulnar nerves, and the palmaris brevis. Remove the palmar fascia, and the superficial palmar arch will be exposed.

It is formed by the termination of the ulnar artery, arching outwards to join the superficial volar branch of the radial, which reaches it by passing downwards amongst the short muscles of the thumb. Covered by the palmar fascia and palmaris brevis, the arch lies on the short muscles of the little finger, the superficial flexor tendons, and the digital branches of the median nerve. The branches it gives off are: deep communicating to complete the deep palmar arch, digital branches, four in number, to supply the three inner fingers, and the ulnar side of the index, and recurrent branches from the concavity of the arch, towards the annular ligament.

32. State the steps of the dissection required to show the course and the relations of the radial artery from the line where it is crossed by the tendon of the extensor ossis metacarpi pollicis to its termination.

Place the limb in a prone position.

Reflect the skin by incisions across the wrist and knuckles.

The artery may be seen immediately below the styloid process of the radius, lying on the external lateral ligament of the wrist joint, and crossed by the extensor ossis metacarpi and extensor primi internodii pollicis. It now passes into the palm between the two heads of the first dorsal interosseous muscles. To see its termination in the palm, place the hand supine, and reflect the skin by means of transverse incisions at the wrist and web of the fingers, joined by a median longitudinal cut.

Remove the subcutaneous cellular tissue with the palmar cutaneous nerves, the palmaris brevis, and palmar fascia. Next remove the superficial palmar arch, the median nerve, the tendons of the flexor sublimis digitorum, those of the flexor profundus digitorum, with the lumbricales, and the flexor brevis pollicis; and the termination of the artery will be seen running across the hand from the first interosseous space, to join a corresponding branch of the ulnar artery, and to form the deep palmar arch. It lies on the metacarpal bones, and interosseous muscles, about a finger's breadth nearer the carpus than the superficial arch.

33. Give the dissection necessary to lay bare, from the origin to the ending, the trunk and branches of the gluteal artery and the superior gluteal nerve.

To show the origin of the gluteal artery, lay open the abdomen, by means of a median incision, with transverse cuts opposite the ninth costal cartilage and the iliac spines, and dissect the internal iliac artery, and its large branch, the gluteal, by removing the peritoneum and loose fat from the side of the pelvis, and also from the lumbo-sacral nerve cord with its branch, the superior gluteal nerve. To see the continuation of the vessel outside the pelvis, place the body on its face, with the lower extremities hanging over the end of the table, the pelvis being supported by a block. Reflect the skin outwards, by means of incisions, backwards along the iliac crest, from the anterior superior spine to the middle line, then downwards to the tip of the coccyx, and from thence obliquely downwards, and outwards, to a point about six inches below the great trochanter.

Remove the subcutaneous cellular tissue, &c., and cut through the gluteus maximus a little external to its origin. Running between it and the subjacent gluteus medius is the superficial branch of the artery. Detach the gluteus medius from its origin, and throw it outwards. This will bring into view the two deep branches of the gluteal artery, and the superior gluteal nerve, lying between the gluteus medius and the gluteus minimus. The lower branch of the artery runs across the gluteus minimus to terminate in the tensor fasciæ femoris, while the upper runs along the upper line of origin of the small gluteus. The nerve is lost in the gluteus medius and minimus and tensor fasciæ femoris muscles.

34. Give the dissection required to expose the quadratus femoris, and mention the parts in immediate relation with it.

Place the subject on its face, with a block under the pelvis, and the legs hanging over the end of the table.

Incisions.—Backwards along iliac crest from the anterior superior spine to the middle line of body, then downwards along the middle line to the tip of the coccyx, and from this point obliquely downwards and outwards to a point six inches below the trochanter major.

Reflect outwards.

Remove the subcutaneous cellular tissue with its contained vessels and nerves, and clean the gluteus maximus.

Cut through the gluteus near the pelvis, and reflect the external part outwards.

The quadratus will be thus laid bare, and it will be found under the lower part of the gluteus, with the sciatic vessels and nerves lying on it.

Contiguous to its upper border is the gemellus inferior, while next below it is the upper border of the adductor magnus, a small terminal branch of the internal circumflex artery, coming to the back between them.

Beneath it are the obturator externus, the internal circumflex artery, and its own nerve and vessels.

35. Describe the method of dissecting the successive layers, and mention briefly the structures found, in a quadrilateral space extending from Poupart's ligament to a line placed parallel to, and four inches below it, going as deep as the muscles.

Incisions.—Along Poupart's ligament, transversely across the thigh, four inches below it, and from the pubes along the inner side of the thigh longitudinally.

Turn outwards the flap thus formed.

Remove the fat (superficial layer of superficial fascia) with the superficial epigastric, external circumflex, and external pudic vessels, and the ilio-inguinal and genito-crural nerves, and the internal saphenous vein.

The removal of the subcutaneous fat will bring into view the deep layer of the superficial fascia. This is a very thin structure, most evident where it covers in the saphenous opening in the deep fascia, at which place it is pierced by the saphenous vein and numerous cutaneous vessels and lymphatics, and hence is called the cribriform fascia. It is attached to the margins of the opening internally by loose areolar tissue, but externally by strong bands of fibrous tissue. This fascia must be raised by means of the handle of the scalpel, commencing on the inner side. On removing it the deep fascia will be exposed. This is a firm membranous aponeurosis, which is so attached above as to have a loop in its upper border, the saphenous opening. The outer part is called its iliac portion, and is attached superficially to Poupart's ligament, while the internal or pubic portion arches deeply beneath the femoral sheath, a loose membrane surrounding the femoral vessels, to be attached to the pectineal line of the pubic bone. The removal of the deep fascia will lay bare the muscles, on which are seen lying from without inwards the external cutaneous nerve; the anterior crural nerve dividing into a cutaneous and a muscular set of branches; the femoral artery and femoral vein, and a large lymphatic gland contained in three compartments of the femoral sheath.

36. What are the relations of the sac of a femoral hernia?

An ordinary femoral hernia passes from the abdomen, through the crural ring into the innermost division of the crural sheath, and then turns forwards, and upwards through the saphenous opening, so that its sac will have in front of it the skin and subcutaneous cellular tissue, the cribriform fascia, the part of the femoral sheath derived from the transversalis fascia, and the septum crurale, whilst behind, the septum crurale and the part of the femoral sheath derived from the iliac fascia separate it from the pectineus.

The relations of the neck of the sac are: In front Poupart's ligament, and remotely the epigastric artery; externally the femoral vein; behind the pubes; and internally Gimbernat's ligament. Occasionally the irregular obturator artery from the epigastric passes first over, and then to the inner side of the sac, but usually the artery, when so derived, takes its course to its outside, and under it.

37. Give the steps of the dissection necessary to lay bare the posterior branch of the obturator nerve.

Place the subject on its back.

Reflect the skin outwards by incisions along Poupart's ligament, from the pubes along the inner side of the thigh as far as the knee, and transversely across the knee.

Reflect the superficial fat from the inner side, next the deep layer of the superficial fascia, and the pubic portion of the fascia lata.

Cut through the origins of, and reflect, the adductor longus, pectineus, and adductor brevis.

This will lay bare the obturator externus and adductor magnus, with the deep or posterior branch of the obturator piercing the former, and running down on the latter. It will be seen to give branches to these muscles, and to the adductor brevis.

The branch to the adductor magnus, if traced through the substance of the muscle, will be found to give off an articular branch to the knee-joint, which runs through the muscle to reach the popliteal artery, and then runs on it to the knee-joint.

38. Describe the dissection of the part of the front of the thigh, included within the following

bounds. Above, take as a limit a transverse line placed three inches higher than the patella (the knee being straight). Below, the tubercle of the tibia; and laterally, the inner and outer intermuscular septa; and the hinder border of the lateral ligaments of the knee-joint (carry the dissection deeply as far as the femur and the anterior crucial ligament).

Reflect the skin. In doing this, a superficial bursa over the patella will be opened.

Next define the patellar plexus, formed by branches from the internal and external cutaneous, the internal saphenous, and its patellar branch. Just at the inner limit of the dissection will be found the internal saphenous trunk, with the superficial branch of the anastomotica magna artery; ramifying with the patellar plexus are some small vessels.

Next clean the deep fascia. This will be seen to blend with the expansion of the extensor tendons, and to be connected below with the heads of the tibia and fibula, being attached along the origins of the vasti laterally to form the external and internal intermuscular septa. Opposite the patella the fascia is strengthened by transverse bands, called the retinaculæ.

Ramifying over the patella are some branches of the articular arteries, and recurrent tibial.

The removal of the deep fascia will bring into view the sartorius muscle, inserting into the inner aspect of the tibia, and the quadriceps extensor inserting into the upper border of the patella, some of its fibres being prolonged over the patella into the ligamentum patellæ.

Reflect the sartorius, and turn down the extensor muscles and the patella. This will expose the subcrureus, a small plane of muscular fibres arising from the lower fourth of the front of the femur, and passing downwards to be inserted into the synovial membrane of the knee-joint. On cleaning away the subcrureus an anastomotic arch between the deep branch of the anastomotica magna and the external superior articular will be exposed. The synovial sac of the knee-joint is the largest in the body, and lines the cavity of the joint and the semi-lunar cartilages, and extends upwards beneath the extensor muscle for a distance beyond the articular surface of the femur. Beneath the patella is a fold of the synovial membrane falling backwards into the joint, and containing a quantity of loose fat, called the ligamentum mucosum; the free borders of this extend downwards, and outwards, and inwards respectively, and are called the ligamenta alaria.

The removal of the synovial membrane will now show the anterior crucial ligament, extending from the front of the spine of the tibia to the back of the external condyle of the femur and intercondyloid fossa.

39. What parts would you remove in order to exhibit the deep muscles of the back of the leg?

In order to lay bare the deep muscles of the leg, it would be necessary to remove the skin, the subcutaneous cellular tissue, with the external saphenous vein, and the small superficial artery accompanying it, the communicantes poplitei and peronei joining to form the external saphenous nerve, the termination of the small sciatic, and some branches of the internal saphenous nerve; the deep fascia; the gastrocnemius, the soleus, and the plantaris muscles; the process of the deep fascia binding down the deep muscles; and the posterior tibial vessels and nerve.

This would lay bare: the popliteus, flexor longus digitorum, flexor longus pollicis, and, partly, the tibialis posticus. To completely bare the last-named muscle, an aponeurosis, giving part origin to the flexor longus pollicis and flexor longus digitorum, must be cut through, and those muscles turned aside, or removed.

40. Describe the dissection of the anterior tibial artery from its commencement to the annular ligament.

Place the limb on its back.

Incisions.—Along crest of tibia, and transversely across knee and ankle.

Reflect outwards.

Clean the tibialis anticus, the extensor longus digitorum, and the extensor proprius pollicis, and separate the first-named from the other two muscles.

The artery will be found lying deeply on the interosseous membrane above, at first between the tibialis anticus and the extensor longus digitorum, but after the first two inches between the former muscle and the extensor proprius pollicis. In its lower third it becomes more superficial, passing on to the front of the tibia and the ankle-joint, lying between the tibialis anticus and extensor longus digitorum, and crossed by the extensor proprius pollicis. The anterior tibial nerve comes into relation with it on the outside, in the middle third, and, after crossing the artery, again arrives on its outer side at the ankle-joint.

Turning round the artery are the two venæ comites, connected by cross branches.

41. Mention the dissection you would make, and the structures exposed in the way, to show the three peronei muscles. Give the precise attachment of these muscles to bone and other structures. Describe their shape, and the arrangement of their tendons; what arteries, veins, and nerves are supplied to or are in relation with them.

Place the limb on its back.

Incisions.—Transverse at the knee, and across the web of the foot, joined by a longitudinal incision along the middle line.

Reflect the flap outwards.

Remove the cellular tissue, and fat, containing cutaneous branches of the external cutaneous, musculo-cutaneous, and external saphenous nerves, together with venous branches, and clean the muscles now exposed.

Most external, and extending as high as the head of the fibula, is the peroneus longus, a spindle-shaped muscle, arising from the head and the upper two-thirds of the outer aspect of the fibula, the origin tapering below, to make room for, the origin of the peroneus brevis internal to it. Below, it ends in a tendon, which is contained, along with the tendon of the peroneus brevis, in the groove behind the outer malleolus. Arising lower down, and internal to it, from the lower two-thirds of the external aspect of the fibula, is the peroneus brevis. Separating these from the muscle next internal is the external intermuscular septum.

The peroneus tertius is situated internal to the peroneus brevis, arising in the lower fourth of the anterior surface of the fibula, being separated from the peroneus brevis only by the external intermuscular septum. It will be seen that it passes underneath the annular ligament, and, extending into a flat tendon, runs to be inserted into the dorsal surface of the fifth metatarsal bone.

If the external annular ligament be cut across, the tendons of the peronei longus and brevis will be seen to pass underneath it, that of the peroneus brevis being covered by that of the longus. The peroneus brevis may now be followed from below the fibula to its insertion into the tuberosity of the fifth metatarsal bone, while the peroneus longus may be traced to the groove in the cuboid bone, where it disappears in the sole.

In order to follow it there the limb must be turned over, and the skin removed from the sole, by transverse cuts at the heel and web, joined by a median incision.

It would be necessary to remove in order : the granular fat, with plantar cutaneous nerves and vessels; the abductor pollicis, flexor brevis digitorum, and abductor minimi digiti; the plantar vessels and nerves ; the flexor accessorius ; flexor longus digitorum, and flexor longus pollicis; the flexor brevis pollicis, and abductor pollicis ; lastly, the long plantar ligament, and the sheath in which the tendon runs. It is inserted into the base of the first metatarsal bone, and by a slip into the internal cuneiform bone and the base of the second metatarsal bone.

42. Describe the dissection required to expose fully the accessory flexor muscle of the foot.

Place the foot over a block, with the sole uppermost.

Incisions.—One along the middle of the sole, with transverse cuts at the back of the heel, and across the web of the toes.

Reflect the flaps.

Remove the granular fat, with the cutaneous branches from the posterior tibial and saphenous nerves.

This will bring into view the plantar fascia, a strong fibrous structure, consisting of three portions, of which the middle is the strongest, and extends from the os calcis forwards, to give a process to each of the toes; the inner is thin, but the outer forms a firm band between the os calcis and the tuberosity of the little toe. This structure must be cut through and reflected, which will expose three muscles. In the middle is the flexor brevis digitorum, extending from the os calcis to be inserted by four rounded tendons into the bases of the second phalanges of the four outer toes, being perforated at their insertion by the tendons of the long flexor. Internally is the abductor pollicis, passing from the inner tubercle of the os calcis to the inner side of the first phalanx of the great toe. Externally is the abductor minimi digiti, extending from the outer tubercle of the os calcis to the outer side of the first phalanx of the little toe. Between the abductor pollicis and the flexor pollicis are seen the internal plantar vessels and nerve, and close to the tuberosity of the fifth metatarsal bone will be seen a small portion of the external plantar.

Remove the above muscles, and the flexor accessorius will be exposed, arising by two heads of origin—the outer, tendinous, from the outer part of the os calcis and the long plantar ligament; the inner, fleshy, from the concave inner surface of the os calcis, and passing forwards to join by tendinous bands with the tendon of the flexor longus digitorum about the middle of the foot. Lying on the muscle will be seen the external plantar vessels and nerves.

43. What parts will be divided by a knife drawn directly from one malleolus to the other across the sole of the foot, cutting to the bone?

The parts divided by such an incision, commencing at the outer malleolus, would be as follows:—

Skin, subcutaneous fat, external saphenous vein, and nerve, plantar fascia, external and internal annular ligaments, tendons of peroneus longus and brevis, middle fasciculus of external lateral ligament, abductor minimi digiti, flexor brevis digitorum, flexor longus digitorum, flexor accessorius, long plantar ligament, abductor pollicis, flexor longus pollicis, external and internal plantar vessels and nerves, tibialis posticus, superficial and deep portions of internal lateral ligament.

44. Describe the method by which you would show the bands of fibres of which the pons Varolii is composed.

The superficial portion of the pons is composed of transverse fibres, connecting together the hemispheres of the cerebellum. Divide these in the middle line, and reflect them outwards, and the superficial longitudinal fibres of the pons from the anterior pyramid to the crusta of the crus cerebri, will be exposed.

Scrape these away, when a second set of transverse fibres will appear, also connecting the cerebellar hemispheres.

Lastly, if these be cut through and scraped away, the deep longitudinal fibres from the lateral column and posterior pyramid will appear, passing on their way to contribute to the tegmentum of the crus cerebri.

With these is the fillet of the olivary body, which may be defined coming from that centre.

45. What is the dissection required to examine in a complete, detached brain the parts which form the fourth ventricle. Describe its boundaries, shape, and relations, and the appearances which are seen within it, explaining the course taken by the various bundles of fibres which contribute to form the cavity.

Place the brain with its base uppermost.

Lift up the cerebellum with the medulla and pons, and separate them from the remainder of the encephalon, by cutting through the cerebral peduncles opposite the anterior part of the corpora quadrigemina. Then place the parts thus removed, with the cerebellum uppermost, and lay open the cavity of the fourth ventricle by cutting vertically through the vermiform process.

The fourth ventricle is a lozenge-shaped cavity situated between the back of the medulla and pons, and the under surface of the cerebellum, and anterior medullary velum.

In its floor is a median groove, on each side of which is an elevation, the fasciculus teres; on the outer side of each of these is a groove containing two depressions, the fovea anterior and posterior. At the upper part of the anterior is a bluish deposit, the locus cæruleus, prolonged upwards from which is a narrow streak of similar colour, the linea violacea. Crossing the floor about its middle are some white transverse lines, and about its lower part some small eminences, corresponding to the nuclei of the eighth and ninth nerves. The lateral boundaries are formed above by the superior peduncles of the cerebellum, and below by the restiform bodies. The roof is formed by the valve of Vieussens, the under surface of the vermiform process, the reflection of the pia mater from the medulla to the cerebellum, and by a thin strip of grey matter attached to the edge of the posterior pyramid and restiform body. The bundles of fibres forming the floor of the fourth ventricle are passing upwards from the cord to the ganglia of the base of the brain, and so to the hemisphere; those in the restiform body pass from the medulla to the cerebellum, while those in the superior peduncles of the cerebellum connect the cerebellum with the cerebrum, through the great ganglia of the base of the brain.

46. The brain having been removed from the cranial cavity, describe the dissection necessary to expose a lateral ventricle and its horns, and the appearance and relations of the objects seen within it.

Place the brain on its base, and slice off the hemisphere horizontally to a level with the corpus callosum.

Next make an antero-posterior incision through the corpus callosum, about a half an inch from its median ridge, into the lateral ventricle, and remove the roof of that cavity. Then lay open the descending horn of the ventricle by slicing away the lateral parts of the hemisphere in its course.

For the objects seen within the lateral ventricle, see Answer 4, chap. IV.

47. Describe the dissection necessary to expose the fifth cerebral ventricle.

Open the lateral ventricles in the manner described in Answer 46, and, by a transverse incision, cut through the portion of the corpus callosum remaining in the middle line.

Then turn its anterior half forwards, detaching it from the septum lucidum, and there will be laid open, between the anterior part of the component laminæ of the latter, the small cavity of the fifth ventricle.

48. Give the steps of the dissection by which you would expose, in an entire brain, the entire course of the anterior commissure.

Slice off the upper part of both hemispheres, down to the level of the corpus callosum.

Next make a longitudinal cut through the whole thickness of that body on each side, about half an inch from the middle line, so as to open the lateral ventricles.

Reflect the roofs of the ventricle, then cut transversely through the central part of the corpus callosum, together with the septum lucidum and body of the fornix, and reflect the parts, one forwards, the other backwards.

Just in front of the anterior pillars of the fornix, between their divergence, will be seen the free portion of the anterior commissure. It should be followed by scraping away the brain matter over its course, which runs out through both the nuclei caudatus and lenticularis, and back through the white matter forming the roof of the descending horn of the lateral ventricle.

49. Mention the parts which must be removed in order to expose the upper surface of the quadrigeminal bodies.

In order to expose the upper surface of the corpora quadrigemina, the following steps must be taken:—

Separate the back part of the hemispheres from each other, and carry a knife perpendicularly through the back part of the corpus callosum and the lyra of the fornix. Then pull apart the hemispheres from each other, and a process of pia mater, the velum interpositum, will be seen entering the transverse fissure of the brain. When this has been removed the corpora quadrigemina will be laid bare.

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